Sybase® Adaptive Server™ Enterprise System Administration Guide

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Sybase, Inc., 6475 Christie Avenue, Emeryville, CA 94608.

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About This Book

This manual, the *Sybase Adaptive Server System Administration Guide*, describes how to administer and control Sybase® Adaptive Server™ Enterprise databases independent of any specific database application.

Audience

This manual is for Sybase System Administrators and Database Owners.

How to Use This Book

This manual contains six sections. Part 1, "Introduction," describes basic system administration issues:

- Chapter 1, "Overview of System Administration," describes the structure of the Sybase system.
- Chapter 2, "System Databases," discusses the contents and function of the Adaptive Server system databases.
- Chapter 3, "System Administration for Beginners," summarizes important tasks that new System Administrators need to perform.
- Chapter 4, "Diagnosing System Problems," discusses Adaptive Server and Backup Server™ error handling and shows how to shut down servers and kill user processes.

Part 2 describes how to manage login accounts and permissions:

- Chapter 5, "Security Administration," provides an overview of the security features available in Adaptive Server.
- Chapter 6, "Managing Adaptive Server Logins and Database Users," describes methods for managing Adaptive Server login accounts and database users.
- Chapter 7, "Managing User Permissions," describes the use and implementation of user permissions.
- Chapter 8, "Auditing," describes how to set up auditing for your installation.

- Chapter 9, “Managing Remote Servers,” discusses the steps the System Administrator and System Security Officer of each Adaptive Server must execute to enable remote procedure calls (RPCs).
- Chapter 10, “Using Network-Based Security,” describes the network-based security services that enable you to authenticate users and protect data transmitted among machines on a network.

Part 3, “Managing Physical Resources,” describes how to set up and use disks, memory, and processors with Adaptive Server:

- Chapter 11, “Overview of Disk Resource Issues,” provides an overview of Adaptive Server disk resource issues.
- Chapter 12, “Initializing Database Devices,” describes how to initialize and use database devices.
- Chapter 13, “Mirroring Database Devices,” describes how to mirror database devices for nonstop recovery from media failures.
- Chapter 14, “Configuring Memory,” explains how to configure Adaptive Server to use the available memory on your system.
- Chapter 15, “Configuring Data Caches,” discusses how to create named caches in memory and bind objects to those caches.
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Part 4, “Configuring Adaptive Server Behavior,” explains how to configure and use different Adaptive Server features:

- Chapter 17, “Setting Configuration Parameters,” summarizes the configuration parameters that you set with **sp_configure**, which control many aspects of Adaptive Server behavior.
- Chapter 18, “Limiting Access to Server Resources,” explains how to create and manage resource limits with Adaptive Server.
- Chapter 19, “Configuring Character Sets, Sort Orders, and Languages,” discusses international issues, such as the files included in the Language Modules and how to configure an Adaptive Server language, sort order, and character set.
- Chapter 20, “Configuring Client / Server Character Set Conversions,” discusses character set conversion between Adaptive Server and clients in a heterogeneous environment.

Part 5, “Managing Databases and Database Objects,” describes how to create and administer databases and segments:

- Chapter 21, “Creating and Managing User Databases,” discusses the physical placement of databases, tables, and indexes, and the allocation of space to them.
- Chapter 22, “Setting Database Options,” describes how to set database options.
- Chapter 23, “Creating and Using Segments,” describes how to use segments, which are named collections of database devices, in databases.
- Chapter 24, “Using the reorg Command,” describes how to use the **reorg** command.
- Chapter 25, “Checking Database Consistency,” describes how to use the database consistency checker, **dbcc**, to detect and fix database problems.

Part 6, “Backup and Recovery,” describes how to develop and execute a backup and recovery plan for the Adaptive Server system.

- Chapter 26, “Developing a Backup and Recovery Plan,” discusses the capabilities of the Backup Server and how to develop your backup strategy.
- Chapter 27, “Backing Up and Restoring User Databases,” discusses how to recover user databases.
- Chapter 28, “Restoring the System Databases,” discusses how to recover system databases.
- Chapter 29, “Managing Free Space with Thresholds,” discusses managing space with thresholds.

Adaptive Server Enterprise Documents

The following documents comprise the Sybase Adaptive Server Enterprise documentation:

- The *Release Bulletin* for your platform – contains last-minute information that was too late to be included in the books.

  A more recent version of the *Release Bulletin* may be available on the World Wide Web. To check for critical product or document information that was added after the release of the product CD, use Technical Library.

- The Adaptive Server installation documentation for your platform – describes installation, upgrade, and configuration procedures for all Adaptive Server and related Sybase products.
- *What's New in Adaptive Server Enterprise?* – describes the new features in Adaptive Server version 12, the system changes added to support those features, and the changes that may affect your existing applications.
- *Transact-SQL User's Guide* – documents Transact-SQL, Sybase's enhanced version of the relational database language. This manual serves as a textbook for beginning users of the database management system. This manual also contains descriptions of the *pubs2* and *pubs3* sample databases.
- *System Administration Guide* – provides in-depth information about administering servers and databases. This manual includes instructions and guidelines for managing physical resources, security, user and system databases, and specifying character conversion, international language, and sort order settings.
- *Adaptive Server Reference Manual* – contains detailed information about all Transact-SQL commands, functions, procedures, and datatypes. This manual also contains a list of the Transact-SQL reserved words and definitions of system tables.
- *Performance and Tuning Guide* – explains how to tune Adaptive Server for maximum performance. This manual includes information about database design issues that affect performance, query optimization, how to tune Adaptive Server for very large databases, disk and cache issues, and the effects of locking and cursors on performance.
- The *Utility Programs* manual for your platform – documents the Adaptive Server utility programs, such as **isql** and **bcp**, which are executed at the operating system level.
- *Error Messages* and *Troubleshooting Guide* – explains how to resolve frequently occurring error messages and describes solutions to system problems frequently encountered by users.
- *Component Integration Services User's Guide* – explains how to use the Adaptive Server Component Integration Services feature to connect remote Sybase and non-Sybase databases.
- *Java in Adaptive Server Enterprise* – describes how to install and use Java classes as datatypes and user-defined functions in the Adaptive Server database.

- *Using Sybase Failover in a High Availability System* – provides instructions for using Sybase's Failover to configure an Adaptive Server as a companion server in a high availability system.
- *Using Adaptive Server Distributed Transaction Management Features* – explains how to configure, use, and troubleshoot Adaptive Server DTM Features in distributed transaction processing environments.
- *XA Interface Integration Guide for CICS, Encina, and TUXEDO* provides instructions for using Sybase's DTM XA Interface with X/Open XA transaction managers.
- *Adaptive Server Glossary* – defines technical terms used in the Adaptive Server documentation.
- *Master Index for Adaptive Server Publications* – combines the indexes of the *Adaptive Server Reference Manual, Component Integration Services User's Guide, Performance and Tuning Guide, Security Administration Guide, Security Features User's Guide, System Administration Guide,* and *Transact-SQL User's Guide*.

Other Sources of Information

Use the SyBooks™ and Technical Library online resources to learn more about your product:

- SyBooks documentation is on the CD that comes with your software. The DynaText browser, also included on the CD, allows you to access technical information about your product in an easy-to-use format.

  Refer to *Installing SyBooks* in your documentation package for instructions on installing and starting SyBooks.
- Technical Library is an HTML version of SyBooks that you can access using a standard Web browser.

  To use Technical Libary, go to http://www.sybase.com, and choose Documentation.

Conventions Used in This Manual

This section describes the style conventions used in this manual.

Formatting SQL Statements

SQL is a free-form language: there are no rules about the number of words you can put on a line or where you must break a line. However, for readability, all examples and syntax statements in this manual are formatted so that each clause of a statement begins on a new line. Clauses that have more than one part extend to additional lines, which are indented.

SQL Syntax Conventions

Table 1 lists the conventions for syntax statements in this manual:

Table 1: Syntax statement conventions

Key	Definition
`command`	Command names, command option names, utility names, utility flags, and other keywords are in **`bold Courier`** in syntax statements, and in **bold Helvetica** in paragraph text.
`variable`	Variables, or words that stand for values that you fill in, are in italics.
`{ }`	Curly braces indicate that you choose at least one of the enclosed options. Do not include braces in your option.
`[ ]`	Square brackets mean choosing one or more of the enclosed options is optional. Do not include brackets in your option.
`( )`	Type parentheses as part of the command.
`|`	The vertical bar means you may select only one of the options shown.
`,`	The comma means you may choose as many of the options shown as you like, separating your choices with commas.

- Syntax statements (displaying the syntax and all options for a command) are printed like this:

```
sp_dropdevice [device_name]
```

or, for a command with more options:

```
select column_name
    from table_name
    where search_conditions
```

In syntax statements, keywords (commands) are in normal font and identifiers are in lowercase: normal font for keywords, italics for user-supplied words.

- Examples showing the use of Transact-SQL commands are printed like this:

```
select * from publishers
```

- Examples of output from the computer are printed like this:

```
pub_id  pub_name                city        state
------- -------------------     ----------- -----
0736    New Age Books           Boston      MA
0877    Binnet & Hardley        Washington  DC
1389    Algodata Infosystems    Berkeley    CA

(3 rows affected)
```

Case

You can disregard case when you type keywords:

SELECT is the same as **Select** is the same as **select**.

Obligatory Options {You Must Choose At Least One}

- **Curly braces and vertical bars:** Choose **one and only one** option.

```
{die_on_your_feet | live_on_your_knees |
live_on_your_feet}
```

- **Curly braces and commas:** Choose **one or more** options. If you choose more than one, separate your choices with commas.

```
{cash, check, credit}
```

Optional Options

- **One item in square brackets:** You don't have to choose it.

```
[anchovies]
```

- **Square brackets and vertical bars:** Choose **none or only one**.

```
[beans | rice | sweet_potatoes]
```

- **Square brackets and commas:** Choose **none, one, or more than one** option. If you choose more than one, separate your choices with commas.

  ```
  [extra_cheese, avocados, sour_cream]
  ```

Ellipsis

An ellipsis (. . .) means that you can **repeat** the last unit as many times as you like. In this syntax statement, **buy** is a required keyword:

```
buy thing = price [cash | check | credit]
    [, thing = price [cash | check | credit]]...
```

You must buy at least one thing and give its price. You may choose a method of payment: one of the items enclosed in square brackets. You may also choose to buy additional things: as many of them as you like. For each thing you buy, give its name, its price, and (optionally) a method of payment.

An ellipsis can also be used inline to signify portions of a command that are left out of a text example. The following syntax statement represents the complete **create database** command, even though required keywords and other options are missing:

```
create database...for load
```

Expressions

Several different types of **expressions** are used in Adaptive Server syntax statements.

Table 2: Types of expressions used in syntax statements

Usage	Definition
expression	Can include constants, literals, functions, column identifiers, variables, or parameters
logical_expression	An expression that returns TRUE, FALSE, or UNKNOWN
constant_expression	An expression that always returns the same value, such as “5+3” or “ABCDE”
float_expr	Any floating-point expression or expression that implicitly converts to a floating value

Table 2: Types of expressions used in syntax statements (continued)

Usage	Definition
integer_expr	Any integer expression or an expression that implicitly converts to an integer value
numeric_expr	Any numeric expression that returns a single value
char_expr	An expression that returns a single character-type value
binary_expression	An expression that returns a single *binary* or *varbinary* value

If You Need Help

Each Sybase installation that has purchased a support contract has one or more designated people who are authorized to contact Sybase Technical Support. If you cannot resolve a problem using the manuals or online help, please have the designated person contact Sybase Technical Support or the Sybase subsidiary in your area.

Introduction

1 Overview of System Administration

This chapter introduces the basic topics of Adaptive Server system administration, including:

Adaptive Server Administration Tasks

Administering Adaptive Server includes tasks such as:

- Installing Adaptive Server and Backup Server
- Creating and managing Adaptive Server login accounts
- Granting roles and permissions to Adaptive Server users
- Managing and monitoring the use of disk space, memory, and connections
- Backing up and restoring databases
- Diagnosing system problems
- Configuring Adaptive Server to achieve the best performance

In addition, System Administrators may have a hand in certain database design tasks, such as enforcing integrity standards. This function may overlap with the work of application designers.

Although a System Administrator concentrates on tasks that are independent of the applications running on Adaptive Server, he or she is likely to be the person with the best overview of all the applications. For this reason, a System Administrator can advise application designers about the data that already exists on Adaptive Server, make recommendations about standardizing data definitions across applications, and so on.

However, the distinction between what is specific to an application is sometimes a bit “fuzzy.” Owners of user databases will consult

certain sections of this book. Similarly, System Administrators and Database Owners will use the *Transact-SQL User's Guide* (especially the chapters on data definition, stored procedures, and triggers). Both System Administrators and application designers will use the *Performance and Tuning Guide*.

Roles Required for System Administration Tasks

Many of the commands and procedures discussed in this manual require the System Administrator or System Security Officer role. Other sections in this manual are relevant to Database Owners. A Database Owner's user name within the database is "dbo". You cannot log in as "dbo:" a Database Owner logs in under his or her Adaptive Server login name and is recognized as "dbo" by Adaptive Server only while he or she is using the database.

Various security-related, administrative, and operational tasks are grouped into the following system roles:

- **System Administrator**, whose tasks include:
  - Managing disk storage
  - Monitoring Adaptive Server's automatic recovery procedure
  - Fine-tuning Adaptive Server by changing configurable system parameters
  - Diagnosing and reporting system problems
  - Backing up and loading databases
  - Granting and revoking the System Administrator role
  - Modifying and dropping server login accounts
  - Granting permissions to Adaptive Server users
  - Creating user databases and granting ownership of them
  - Setting up groups which can be used for granting and revoking permissions)
- **System Security Officer**, who performs security-related tasks such as:
  - Creating server login accounts, which includes assigning initial passwords
  - Changing the password of any account
  - Granting and revoking the System Security Officer and Operator roles

  - Creating, granting, and revoking user-defined roles
  - Granting the capability to impersonate another user throughout the server
  - Setting the password expiration interval
  - Setting up Adaptive Server to use network-based security services
  - Managing the audit system
- **Operator**, a user who can back up and load databases on a server-wide basis. The operator role allows a single user to use the **dump database, dump transaction, load database**, and **load transaction** commands to back up and restore all databases on a server without having to be the owner of each one. These operations can be performed in a single database by the Database Owner or a System Administrator.

These roles provide individual accountability for users performing operational and administrative tasks. Their actions can be audited and attributed to them. A System Administrator operates outside the discretionary access control (DAC) protection system; that is, when a System Administrator accesses objects Adaptive Server does not check the DAC permissions.

In addition, two kinds of object owners have special status because of the objects they own. These ownership types are:

- Database Owner
- Database object owner

Database Owner

The **Database Owner** is the creator of a database or someone to whom database ownership has been transferred. A System Administrator grants users the authority to create databases with the **grant** command.

A Database Owner logs in to Adaptive Server using his or her assigned login name and password. In other databases, that owner is known by his or her regular user name. In the database Adaptive Server recognizes the user as having the “dbo” account.

A Database Owner can:

- Run the system procedure **sp_adduser** to allow other Adaptive Server users access to the database

- Use the **grant** command to give other users permission to create objects and execute commands within the database

Adding users to databases is discussed in Chapter 6, "Managing Adaptive Server Logins and Database Users." Granting permissions to users is discussed in Chapter 7, "Managing User Permissions."

The Database Owner does not automatically receive permissions on objects owned by other users. However, a Database Owner can temporarily assume the permissions of other users in the database at any time by using the **setuser** command. Using a combination of the **setuser** and **grant** commands, the Database Owner can acquire permissions on any object in the database.

➤ ***Note***

Because the Database Owner role is so powerful, the System Administrator should plan carefully who should own databases in the server. The System Security Officer should consider auditing the database activity of all Database Owners.

Database Object Owner

A **Database object owner** is a user who creates a database object. **Database objects** are tables, indexes, views, defaults, triggers, rules, constraints, and procedures. Before a user can create a database object, the Database Owner must grant the user permission to create objects of a particular type. There is no special login name or password for a database object owner.

The database object owner creates an object using the appropriate **create** statement, and then grants permission to other users.

The creator of a database object is automatically granted all permissions on that object. The System Administrator also has all permissions on the object. The owner of an object must explicitly grant permissions to other users before they can access the object. Even the Database Owner cannot use an object directly unless the object owner grants him or her the appropriate permission. However, the Database Owner can always use the **setuser** command to impersonate any other user in the database, including the object owner.

➤ ***Note***

When a database object is owned by someone other than the Database Owner, the user (including a System Administrator) must qualify the name of that object with the object owner's name—*ownername.objectname*—to access the object. If an object or a procedure needs to be accessed by a large number of users, particularly in ad hoc queries, having these objects owned by "dbo" greatly simplifies access.

Using *isql* to Perform System Administration Tasks

This book assumes that you will perform the system administration tasks described in this guide by using the command-line utility **isql**. This section provides some basic information about using **isql**. For complete information about **isql**, see the *Utility Programs* manual for your platform.

You can also use the graphic tool Sybase Central™ to perform many of the tasks described in this book, as described in "Using Sybase Central for System Administration Tasks" on page 1-6.

Starting *isql*

To start **isql** on most platforms, type this command at an operating system prompt:

```
isql -Uusername
```

where *username* is the user name of the System Administrator. Adaptive Server prompts you for your password.

➤ ***Note***

Do not use the **-P** option of **isql** to specify your password because another user might then see your password.

You can use **isql** in command-line mode to enter many of the Transact-SQL examples in this manual.

Entering Statements

The statements that you enter in **isql** can span several lines. **isql** does not process statements until you type "go" on a separate line. For example:

```
1> select *
2> from sysobjects
3> where type = "TR"
4> go
```

The examples in this manual do not include the **go** command between statements. If you are typing the examples, you must enter the **go** command to see the sample output.

Saving and Reusing Statements

This manual frequently suggests you that save the Transact-SQL statements you use to create or modify user databases and database objects. The easiest way to do this is to create or copy the statements to an ASCII-formatted file. You can then use the file to supply statements to **isql** if you need to re-create databases or database objects later.

The syntax for using **isql** with an ASCII-formatted file is:

```
isql -Uusername -ifilename
```

where *filename* is the full path and file name of the file that contains Transact-SQL statements. On UNIX and other platforms, use the less than symbol (**<**) to redirect the file.

The Transact-SQL statements in the ASCII file must use valid syntax and the **go** command.

Using Sybase Central for System Administration Tasks

You can accomplish many of the system administration tasks detailed in this book with Sybase Central, a graphic tool that comes with Adaptive Server.

Here are some of the tasks you can use Sybase Central for:

- Initializing database devices (Windows NT servers only)
- Setting configuration parameters
- Viewing the amount of free log space in a database
- Generating data definition language (DDL)

- Creating logins
- Adding remote servers
- Creating databases
- Creating stored procedures
- Defining roles
- Adding data caches
- Setting database options
- Backing up and restoring databases

You can also use the Monitor Viewer feature of Sybase Central to access Adaptive Server Monitor™. For more information on using Sybase Central, see *Managing and Monitoring Sybase Adaptive Server Enterprise* in the SyBooks Adaptive Server Enterprise Monitor collection. Sybase Central also comes with extensive online help.

You can use the Sybase Central DDL-generation feature to record your work to Transact-SQL scripts. The DDL-generation feature lets you save to a script the actions you performed in an entire server or within a specific database.

System Tables

The *master* database contains **system tables** that keep track of information about Adaptive Server as a whole. In addition, each database (including the *master* database) contains system tables that keep track of information specific to that database.

All the Adaptive Server-supplied tables in the *master* database (Adaptive Server's controlling database) are considered system tables. Each user database is created with a subset of these system tables. The system tables may also be referred to as the **data dictionary** or the system catalogs.

A *master* database and its tables are created when Adaptive Server is installed. The system tables in a user database are created when the **create database** command is issued. The names of all system tables start with "sys". You cannot create tables in user databases that have the same names as system tables. An explanation of the system tables and their columns is included in the *Adaptive Server Reference Manual*.

Querying the System Tables

You can query system tables just like any other tables. For example, the following statement returns the names of all the triggers in the database:

```
select name
from sysobjects
where type = "TR"
```

In addition, Adaptive Server supplies **stored procedures** (called **system procedures**), many of which provide shortcuts for querying the system tables.

Here are the system procedures that provide information from the system tables:

- **sp_commonkey**
- **sp_configure**
- **sp_countmedatada**
- **sp_dboption**
- **sp_estspace**
- **sp_help**
- **sp_helpartition**
- **sp_helpcache**
- **sp_helpconfig**
- **sp_helpconstraint**
- **sp_helpdb**
- **sp_helpdevice**
- **sp_helpgroup**
- **sp_helpindex**
- **sp_helpjava**
- **sp_helpjoins**
- **sp_helpkey**
- **sp_helplanguage**
- **sp_helplog**
- **sp_helpremotelogin**
- **sp_help_resource_limit**
- **sp_helprotect**
- **sp_helpsegment**
- **sp_helpserver**
- **sp_helpsort**
- **sp_helptext**
- **sp_helpthreshold**
- **sp_helpuser**
- **sp_lock**
- **sp_monitor**
- **sp_monitorconfig**
- **sp_procqmode**
- **sp_showcontrolinfo**
- **sp_showexeclass**
- **sp_showplan**
- **sp_spaceused**
- **sp_who**
- **sp_help_resource_limit**

For complete information about the system procedures, see the *Adaptive Server Reference Manual*.

Keys in System Tables

Primary, foreign, and common keys for the system tables are defined in the *master* and *model* databases. You can get a report on defined keys by executing **sp_helpkey.** For a report on columns in two system tables that are likely join candidates, execute **sp_helpjoins.**

The *Adaptive Server System Tables Diagram* included with Adaptive Server shows the relationships between columns in the system tables.

Updating System Tables

The Adaptive Server system tables contain information that is critical to the operation of your databases. Under ordinary circumstances, you do not need to perform direct data modifications to system tables.

Update system tables only when you are instructed to do so by Sybase Technical Support or by an instruction in the *Troubleshooting Guide* or in this manual.

When you update system tables, you must issue an **sp_configure** command that enables system table updates. While this command is in effect, any user with appropriate permission can modify a system table. Other requirements for direct changes to system tables are:

- Modify system tables only inside a transaction. Issue a **begin transaction** command before you issue the data modification command.
- Verify see that only the rows you wanted changed were affected by the command and that the data was changed correctly.
- If the command was incorrect, issue a **rollback transaction** command. If the command was correct, issue a **commit transaction** command.

◆ ***WARNING!***

Some system tables should not be altered by any user under any circumstances. Some system tables are built dynamically by system processes, contain encoded information, or display only a portion of their data when queried. Imprudent, ad hoc updates to certain system tables can make Adaptive Server unable to run, make database objects inaccessible, scramble permissions on objects, or terminate a user session.

Moreover, you should never attempt to alter the definition of the system tables in any way. For example, do not alter system tables to include constraints. Triggers, defaults, and rules are not allowed in system tables. If you try to create a trigger or bind a rule or default to a system table, you will get an error message.

System Procedures

The names of all system procedures begin with "sp_". They are located in the *sybsystemprocs* database, but you can run many of them in any database by issuing the stored procedure from the database or by qualifying the procedure name with the database name.

If you execute a system procedure in a database other than *sybsystemprocs*, it operates on the system tables in the database from which it was executed. For example, if the Database Owner of *pubs2* runs **sp_adduser** from *pubs2* or issues the command **pubs2..sp_adduser**, the new user is added to *pubs2..sysusers*. However, this does not apply to system procedures that update only tables in the *master* database.

Permissions on system procedures are discussed in the *Adaptive Server Reference Manual*.

Using System Procedures

A **parameter** is an argument to a stored or system procedure. If a parameter value for a system procedure contains reserved words, punctuation, or embedded blanks, it must be enclosed in single or double quotes. If the parameter is an object name, and the object name is qualified by a database name or owner name, the entire name must be enclosed in single or double quotes.

System procedures can be invoked by sessions using either chained or unchained transaction mode. However, the system procedures that modify data in system tables in the *master* database cannot be executed from within a transaction, since this could compromise recovery. The system procedures that create temporary work tables cannot be run from transactions.

If no transaction is active when you execute a system procedure, Adaptive Server turns off chained mode and sets **transaction isolation level 1** for the duration of the procedure. Before returning, the session's chained mode and isolation level are reset to their original settings. For more information about transaction modes and isolation levels, see the *Adaptive Server Reference Manual*.

All system procedures report a return status. For example:

```
return status = 0
```

means that the procedure executed successfully.

System Procedure Tables

The system procedures use several **system procedure tables** in the *master* and *sybsystemdb* databases to convert internal system values (for example, status bits) into human-readable format. One of these tables, *spt_values*, is used by a variety of system procedures, including:

- **sp_configure**
- **sp_dboption**
- **sp_depends**
- **sp_help**
- **sp_helpdb**
- **sp_helpdevice**
- **sp_helpindex**
- **sp_helpkey**
- **sp_helprotect**
- **sp_lock**

The *spt_values* table can be updated only by an upgrade; it cannot be modified otherwise. To see how it is used, execute **sp_helptext** and look at the text for one of the system procedures that references it.

The other system procedure tables are *spt_monitor*, *spt_committab*, and tables needed by the catalog stored procedures. (The *spt_committab* table is located in the *sybsystemdb* database.)

In addition, several of the system procedures create and then drop temporary tables. For example, **sp_helpdb** creates *#spdbdesc*, **sp_helpdevice** creates *#spdevtab*, and **sp_helpindex** creates *#spindtab*.

Creating System Procedures

Many of the system procedures are explained in this manual, in the sections where they are relevant. For complete information about system procedures, see the *Adaptive Server Reference Manual*.

System Administrators can write system procedures that can be executed in any database. Simply create a stored procedure in *sybsystemprocs* and give it a name that begins with "sp_". The *uid* of the stored procedure must be 1, the *uid* of the Database Owner.

Most of the system procedures that you create query the system tables. You can also create stored procedures that modify the system tables, although this is not recommended.

To create a stored procedure that modifies system tables, a System Security Officer must first turn on the **allow updates to system tables** configuration parameter. Any stored procedure created while this parameter is set to "on" will **always** be able to update system tables, even when **allow updates to system tables** is set to "off." To create a stored procedure that updates the system tables:

1. Use **sp_configure** to set **allow updates to system tables** to "on."
2. Create the stored procedure with the **create procedure** command.
3. Use **sp_configure** to set **allow updates to system tables** to "off."

◆ ***WARNING!***

Use extreme caution when you modify system tables. Always test the procedures that modify system tables in development or test databases, not in your production database.

System Extended Stored Procedures

An extended stored procedure (ESP) provides a way to call external language functions from within Adaptive Server. Adaptive Server provides a set of ESPs; users can also create their own. The names of all system extended stored procedures begin with "xp_", and are located in the *sybsystemprocs* database.

One very useful system ESP is **xp_cmdshell**, which executes an operating system command on the system that is running Adaptive Server.

You can invoke a system ESP just like a system procedure. The difference is that a system ESP executes procedural language code rather than Transact-SQL statements. All ESPs are implemented by an Open Server application called XP Server, which runs on the same machine as Adaptive Server. XP Server starts automatically on the first ESP innovation.

For information about the system ESPs provided with Adaptive Server, see the *Adaptive Server Reference Manual.*

Creating System ESPs

Create a system ESP in the *sybsystemprocs* database using the **create procedure** command. System procedures are automatically included in the *sybsystemprocs* database. The name of the ESP, and its procedural language function, should begin with "xp_". The *uid* of the stored procedure must be 1, the *uid* of the Database Owner.

For general information about creating ESPs, see "Using Extended Stored Procedures" in the *Transact-SQL User's Guide.*

Logging Error Messages

Adaptive Server writes start-up information to a local error log file each time it boots. The installation program automatically sets the error log location when you configure a new Adaptive Server. See the configuration documentation for your platform to learn the default location and file name of the error log.

Many error messages from Adaptive Server go to the user's terminal only. However, fatal error messages (severity levels 19 and above), kernel error messages, and informational messages from Adaptive Server are recorded in the error log file.

Adaptive Server keeps the error log file open until you stop the server process. If you need to reduce the size of the error log by deleting old messages, stop the Adaptive Server process before you do so.

➤ ***Note***

On some platforms such as Windows NT, Adaptive Server also records error messages in the operating system event log. See the Adaptive Server installation and configuration guide for additional information about error logs.

Connecting to Adaptive Server

Adaptive Server can communicate with other Adaptive Servers, Open Server applications, and client software on the network. Clients can talk to one or more servers, and servers can communicate with other servers via remote procedure calls. In order for products to interact with one another, each needs to know where the others reside on the network. This network service information is stored in the interfaces file.

The Interfaces File

The interfaces file is usually named *interfaces*, *interfac*, or *sql.ini*, depending on the operating system.

The interfaces file is like an address book. It lists the name and address of every known server. When you use a client program to connect to a server, the program looks up the server name in the interfaces file and then connects to the server using the address, as shown in Figure 1-1.

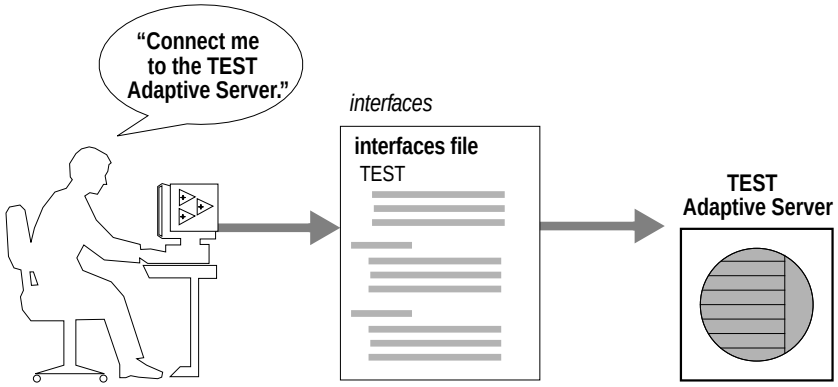

Figure 1-1: Connecting to Adaptive Server

The name, location, and contents of the interfaces file differ between operating systems. Also, the format of the Adaptive Server addresses in the interfaces file differs between network protocols.

When you install Adaptive Server, the installation program creates a simple interfaces file that you can use for local connections to Adaptive Server over one or more network protocols. As a System Administrator, it is your responsibility to modify the interfaces file and distribute it to users so that they can connect to Adaptive Server over the network. See the configuration documentation for your platform for information about the interfaces file for your platform.

Directory Services

A directory service manages the creation, modification, and retrieval of network service information. Directory services are provided by platform or third-party vendors and must be purchased and installed separately from Adaptive Server. Two examples of directory services are NT Registry and Distributed Computing Environment (DCE).

The *$SYBASE/config/libtcl.cfg* file is a Sybase-supplied configuration file used by servers and clients to determine:

- Which directory service to use, and
- The location of the specified directory service driver.

If no directory services are installed or listed in the *libtcl.cfg* file, Adaptive Server defaults to the interfaces file for obtaining network service information.

The System Administrator must modify the *libtcl.cfg* file as appropriate for the operating environment.

Some directory services are specific to a given platform; others can be used on several different platforms. Because of the platform-specific nature of directory services, refer to the configuration documentation for your platform for detailed information on configuring for directory services.

Security Features Available in Adaptive Server

SQL Server release 11.0.6 passed the security evaluation by the National Security Agency (NSA) at the Class C2 criteria. (The requirements for the C2 criteria are given by the Department of Defense in DOD 52.00.28-STD, *Department of Defense Trusted Computer System Evaluation Criteria* [TCSEC], also known as the "Orange Book.")

The configuration of SQL Server release 11.0.6 that was evaluated at the C2 security level by the NSA in 1996 on the HP 9000 HP-UX BLS, 9.09+ platform is referred to as the **evaluated configuration**. Certain features of SQL Server, such as remote procedures and direct updates to system tables, were excluded from the evaluated configuration. Notes in the Adaptive Server documentation indicate particular features that were not included in the evaluated configuration. For a complete list of features that were excluded from the evaluated configuration, see Appendix A in the *SQL Server Installation and Configuration Guide for HP 9000 HP-UX BLS, 9.09+*.

Adaptive Server version 11.5 contains all of the security features included in SQL Server release 11.0.6 plus some new security features. Table 1-1 summarizes the major features.

Table 1-1: Major security features

Security Feature	Description
Discretionary Access Controls (DAC)	Provides access controls that give object owners the ability to restrict access to objects, usually with the **grant** and **revoke** commands. This type of control is dependent upon an object owner's discretion.
Identification and authentication controls	Ensures that only authorized users can log in to the system.

Table 1-1: Major security features (continued)

Security Feature	Description
Division of roles	Allows you to grant privileged roles to specified users so that only designated users can perform certain tasks. Adaptive Server has predefined roles, called "system roles," such as **System Administrator** and **System Security Officer**. In addition, Adaptive Server allows System Security Officers to define additional roles, called "user-defined roles."
Network-based security	Provides security services to authenticate users and protect data transmitted among machines on a network.
Auditing	Provides the capability to audit events such as logins, logouts, server boot operations, remote procedure calls, accesses to database objects, and all actions by a specific user or with a particular role active. In addition, Adaptive Server provides a single option to audit a set of server-wide security-relevant events.

2 System Databases

This chapter describes the system databases that reside on all Adaptive Server systems. It also describes optional Sybase-supplied databases that you can install, and a database that Sybase Technical Support may install for diagnostic purposes. Topics include:

Overview of System Databases

When you install Adaptive Server, it includes these system databases:

- The *master* database
- The *model* database
- The system procedure database, *sybsystemprocs*
- The temporary database, *tempdb*

Optionally, you can install:

- The auditing database, *sybsecurity*
- The two-phase commit transaction database, *sybsystemdb*
- The sample databases, *pubs2* and *pubs3*
- The **dbcc** database, *dbccdb*

For information about installing the *master*, *model*, *sybsystemprocs*, and *tempdb* databases, see the installation documentation for your

platform. For information on installing *dbccdb*, see Chapter 25, "Checking Database Consistency."

The *master*, *model*, and temporary databases reside on the device named during installation, which is known as the master device. The *master* database is contained entirely on the master device and cannot be expanded onto any other device. All other databases and user objects should be created on other devices.

◆ ***WARNING!***

Do not store user databases on the master device. Storing user databases on the master device makes it difficult to recover the system databases if they become damaged. Also, you will not be able to recover user databases stored on the master device.

You should install the *sybsecurity* and *sybsystemdb* databases on their own devices and segment. For more information, see the installation documentation for your platform.

You can install the *sybsystemprocs* database on a device of your choice. You may want to modify the installation scripts for *pubs2* and *pubs3* to share the device you create for *sybsystemprocs*.

The *installpubs2* and the *installpubs3* scripts do not specify a device in their **create database** statement, so they are created on the default device. At installation time, the master device is the default device. To change this, you can either edit the scripts or follow the instructions in Chapter 12, "Initializing Database Devices," for information about adding more database devices and designating default devices.

master Database

The *master* database controls the operation of Adaptive Server and stores information about all user databases and their associated database devices. Table 2-1 describes information the *master* database tracks.

Table 2-1: Information the master database tracks

Information	System Table
User accounts	*syslogins*
Remote user accounts	*sysremotelogins*

Table 2-1: Information the master database tracks (continued)

Information	System Table
Remote servers that this server can interact with	*sysservers*
Ongoing processes	*sysprocesses*
Configurable environment variables	*sysconfigures*
System error messages	*sysmessages*
Databases on Adaptive Server	*sysdatabases*
Storage space allocated to each database	*sysusages*
Tapes and disks mounted on the system	*sysdevices*
Active locks	*syslocks*
Character sets	*syscharsets*
Languages	*syslanguages*
Users who hold server-wide roles	*sysloginroles*
Server roles	*syssrvroles*
Adaptive Server engines that are online	*sysengines*

Because the *master* database stores information about user databases and devices, you must be in the *master* database in order to issue the **create database**, **alter database**, **disk init**, **disk refit**, **disk reinit**, and disk mirroring commands.

Controlling Object Creation in *master*

When you first install Adaptive Server, only a System Administrator can create objects in the *master* database, because the System Administrator implicitly becomes "dbo" of any database he or she uses. Any objects created on the *master* database should be used for the administration of the system as a whole. Permissions in *master* should remain set so that most users cannot create objects there.

◆ ***WARNING!***

Never place user objects in *master*. Storing user objects in *master* can cause the transaction log to fill quickly. If the transaction log runs out of space completely, you will not be able to use dump transaction commands to free space in *master*.

Another way to discourage users from creating objects in *master* is to change the default database for users (the database to which a user is connected when he or she logs in) with **sp_modifylogin**. See Chapter 6, "Adding Users to Databases," for more information.

If you create your own system procedures, create them in the *sybsystemprocs* database rather than in *master*.

Backing Up *master* and Keeping Copies of System Tables

To be prepared for hardware or software failure on Adaptive Server, the two most important housekeeping tasks are:

- Performing frequent backups of the *master* database and all user databases. See "Keep Up-to-Date Backups of Master" on page 3-7 for more information. See also Chapter 28, "Restoring the System Databases," for an overview of the process for recovering the *master* database.
- Keeping a copy (preferably offline) of these system tables: *sysusages*, *sysdatabases*, *sysdevices*, *sysloginroles*, and *syslogins*. See "Keep Offline Copies of System Tables" on page 3-8 for more information. If you have copies of these scripts, and a hard disk crash or other disaster makes your database unusable, you can use the recovery procedures described in Chapter 28, "Restoring the System Databases." If you do not have current copies of your scripts, it will be much more difficult to recover Adaptive Server when the *master* database is damaged.

model Database

Adaptive Server includes the *model* database, which provides a template, or prototype, for new user databases. Each time a user enters the **create database** command, Adaptive Server makes a copy of the *model* database and extends the new database to the size specified by the **create database** command.

➤ ***Note***

A new database cannot be smaller than the *model* database.

The *model* database contains the required system tables for each user database. You can modify *model* to customize the structure of newly created databases—everything you do to *model* will be reflected in

each new database. Some of the changes that System Administrators commonly make to *model* are:

- Adding user-defined datatypes, rules, or defaults.
- Adding users who should have access to all databases on Adaptive Server.
- Granting default privileges, particularly for "guest" accounts.
- Setting database options such as **select into/bulkcopy/pllsort**. The settings will be reflected in all new databases. Their original value in *model* is **off**. For more information about the database options, see Chapter 22, "Setting Database Options."

Typically, most users do not have permission to modify the *model* database. There is not much point in granting read permission either, since Adaptive Server copies its entire contents into each new user database.

The size of *model* cannot be larger than the size of *tempdb*. Adaptive Server displays an error message if you try to increase the size of *model* without making *tempdb* at least as large.

➤ ***Note***

Keep a backup copy of the *model* database, and back up *model* with **dump database** each time you change it. In case of media failure, restore *model* as you would a user database.

sybsystemprocs Database

Sybase system procedures are stored in the database *sybsystemprocs*. When a user in any database executes any stored procedure, Adaptive Server first looks for that procedure in the user's current database. If there is no procedure there with that name, Adaptive Server looks for it in *sybsystemprocs*. If there is no procedure in *sybsystemprocs* by that name, Adaptive Server looks for the procedure in *master*.

If the procedure modifies system tables (for example, **sp_adduser** modifies the *sysusers* table), the changes are made in the database from which the procedure was executed.

To change the default permissions on system procedures, you must modify those permissions in *sybsystemprocs*.

➤ ***Note***

Any time you make changes to *sybsystemprocs*, you should back up the database.

tempdb Database

Adaptive Server has a **temporary database**, *tempdb*. It provides a storage area for temporary tables and other temporary working storage needs. The space in *tempdb* is shared among all users of all databases on the server.

The default size of *tempdb* is 2MB. Certain activities may make it necessary to increase the size of *tempdb*. The most common of these are:

- Large temporary tables.
- A lot of activity on temporary tables, which fills up the *tempdb* logs.
- Large sorts or many simultaneous sorts. Subqueries and aggregates with **group by** also cause some activity in *tempdb*.

You can increase the size of *tempdb* with **alter database**. *tempdb* is initially created on the master device. Space can be added from the master device or from any other database device.

Creating Temporary Tables

No special permissions are required to use *tempdb*, that is, to create temporary tables or to execute commands that may require storage space in the temporary database.

Create temporary tables either by preceding the table name in a **create table** statement with a pound sign (#) or by specifying the name prefix "tempdb..".

Temporary tables created with a pound sign are accessible only by the current Adaptive Server session: users on other sessions cannot access them. These nonsharable, temporary tables are destroyed at the end of each session. The first 13 bytes of the table's name, including the pound sign (#), must be unique. Adaptive Server assigns the names of such tables a 17-byte number suffix. (You can see the suffix when you query *tempdb..sysobjects*.)

Temporary tables created with the “tempdb..” prefix are stored in *tempdb* and can be shared among Adaptive Server sessions. Adaptive Server does not change the names of temporary tables created this way. The table exists either until you restart Adaptive Server or until its owner drops it using **drop table**.

System procedures work on temporary tables, but only if you use them from *tempdb*.

If a stored procedure creates temporary tables, the tables are dropped when the procedure exits. Temporary tables can also be dropped explicitly before a session ends.

◆ ***WARNING!***

Do not create temporary tables with the "tempdb.." prefix from inside a stored procedure unless you intend to share those tables among other users and sessions.

Each time you restart Adaptive Server, it copies *model* to *tempdb*, which clears the database. Temporary tables are not recoverable.

sybsecurity Database

The *sybsecurity* database contains the audit system for Adaptive Server. It consists of:

- The system tables, *sysaudits_01*, *sysaudits_02*, ... *sysaudits_08*, which contain the audit trail
- The *sysauditoptions* table, which contains rows describing the global audit options
- All other default system tables that are derived from *model*

The audit system is discussed in more detail in Chapter 8, “Auditing,”.

sybsystemdb Database

The *sybsystemdb* database stores information about distributed transactions. Adaptive Server version 12.x can provide transaction coordination services for transactions that are propagated to remote servers using remote procedure calls (RPCs) or Component Integration System (CIS). Information about remote servers

participating in distributed transactions is stored in the *syscoordinations* table.

➤ ***Note***

Adaptive Server version 12.x distributed transaction management services are available as a separately-licensed feature. You must purchase and install a valid license for Distributed Transaction Management before it can be used. See *Using Adaptive Server Distributed Transaction Management Features* and the installation guide for more information.

The *sybsystemdb* database also stores information about SYB2PC transactions that use the Sybase two-phase commit protocol. The *spt_committab* table, which stores information about and tracks the completion status of each two-phase commit transaction, is stored in the *sybsystemdb* database.

Two-phase commit transactions and how to create the *sybsystemdb* database is discussed in detail in the configuration documentation for your platform.

pubs2 and *pubs3* Sample Databases

Installing the *pubs2* and *pubs3* sample databases is optional. These databases are provided as a learning tool for Adaptive Server. The *pubs2* sample database is used for most of the examples in the Adaptive Server documentation, except for examples, where noted, that use the *pubs3* database. For information about installing *pubs2* and *pubs3*, see the installation documentation for your platform. For information about the contents of these sample databases, see the *Transact-SQL User's Guide*.

Maintaining the Sample Databases

The sample databases contain a "guest" user that allows access to the database by any authorized Adaptive Server user. The "guest" user has been given a wide range of privileges in *pubs2* and *pubs3*, including permissions to select, insert, update, and delete user tables. For more information about the "guest" user and a list of the guest permissions in *pubs2* and *pubs3*, see Chapter 6, "Managing Adaptive Server Logins and Database Users."

The *pubs2* and *pubs3* databases require at least 2MB each. If possible, you should give each new user a clean copy of *pubs2* and *pubs3* so that she or he is not confused by other users' changes. If you want to place *pubs2* or *pubs3* on a specific database device, edit the installation script before installing the database.

If space is a problem, you can instruct users to issue the **begin transaction** command before updating a sample database. After the user has finished updating one of the sample databases, he or she can issue the **rollback transaction** command to undo the changes.

pubs2 image Data

Adaptive Server includes a script for installing *image* data in the *pubs2* database (*pubs3* does not use the image data). The *image* data consists of six pictures, two each in PICT, TIF, and Sun raster file formats. Sybase does not provide any tools for displaying *image* data. You must use the appropriate screen graphics tools to display the images after you extract them from the database.

See the the installation documentation for your platform for information about installing the *image* data in *pubs2*.

dbccdb Database

dbcc checkstorage records configuration information for the **target database**, operation activity, and the results of the operation in the *dbccdb* database. Stored in the database are **dbcc** stored procedures for creating and maintaining *dbccdb* and for generating reports on the results of **dbcc checkstorage** operations. For more information, see Chapter 25, "Checking Database Consistency."

sybdiag Database

Sybase Technical Support may create the *sybdiag* database on your system for debugging purposes. This database holds diagnostic configuration data, and should not be used by customers.

3 System Administration for Beginners

This chapter:

- Introduces new System Administrators to important topics
- Helps System Administrators find information in the Sybase documentation

Topics include:

Experienced administrators may also find this chapter useful for organizing their ongoing maintenance activities.

Using “Test” Servers

It is always best to install and use a “test” and/or “development” Adaptive Server, then remove it before you create the “production” server. Using a test server makes it easier to plan and test different configurations and less stressful to recover from mistakes. It is much easier to learn how to install and administer new features when there is no risk of having to restart a production server or re-create a production database.

If you decide to use a test server, we suggest that you do so from the point of installing or upgrading Adaptive Server through the process of configuring the server. It is in these steps that you make some of the most important decisions about your final production system. The following sections describe the ways in which using a test server can help System Administrators.

Understanding New Procedures and Features

Using a test server allows you to practice basic administration procedures before performing them in a production environment. If you are a new Adaptive Server administrator, many of the procedures discussed in this book may be unfamiliar to you, and it may take several attempts to complete a task successfully. However, even experienced administrators will benefit from practicing techniques that are introduced by new features in Adaptive Server.

Planning Resources

Working with a test server helps you plan the final resource requirements for your system and helps you discover resource deficiencies that you might not have anticipated.

In particular, disk resources can have a dramatic effect on the final design of the production system. For example, you may decide that a particular database requires nonstop recovery in the event of a media failure. This would necessitate configuring one or more additional database devices to mirror the critical database. Discovering these resource requirements in a test server allows you to change the physical layout of databases and tables without affecting database users.

You can also use a test server to benchmark both Adaptive Server and your applications using different hardware configurations. This allows you to determine the optimal setup for physical resources at both the Adaptive Server level and the operating system level before bringing the entire system online for general use.

Achieving Performance Goals

Most performance objectives can be met only by carefully planning a database’s design and configuration. For example, you may discover that the insert and I/O performance of a particular table is a bottleneck. In this case, the best course of action may be to re-create the table on a dedicated segment and partition the table. Changes of this nature are disruptive to a production system; even changing a configuration parameter may require you to restart Adaptive Server.

Installing Sybase Products

The responsibility for installing Adaptive Server and other Sybase products is sometimes placed with the System Administrator. If installation is one of your responsibilities, use the following pointers to help you in the process.

Check Product Compatibility

Before installing new products or upgrading existing products, always read the release bulletin included with the products to understand any compatibility issues that might affect your system. Compatibility problems can occur between hardware and software and between different release levels of the same software. Reading the release bulletin in advance can save the time and guesswork of troubleshooting known compatibility problems.

Also, refer to the lists of known problems that are installed with Adaptive Server. See the release bulletin for more information.

Install or Upgrade Adaptive Server

Read through the installation documentation for your platform before you begin a new installation or upgrade. You need to plan parts of the installation and configure the operating system **before** installing Adaptive Server. It is also helpful to consult with the operating system administrator to discuss operating system requirements for Adaptive Server. These requirements can include the configuration of memory, raw devices, asynchronous I/O, and other features, depending on the platform you use. Many of these tasks must be completed before you have begun the installation.

If you are upgrading a server, back up all data (including the *master* database, user databases, triggers, and system procedures) offline before you begin. After upgrading, immediately create a separate, full backup of your data, especially if there are incompatibilities between older dump files and the newer versions.

Install Additional Third-Party Software

Network Protocols

Adaptive Server generally includes support for the network protocol(s) that are common to your hardware platform. If your network supports additional protocols, install the required protocol support.

Directory Services

As an alternative to the Sybase interfaces file, you can use a directory service to obtain a server's address and other network information. Directory services are provided by platform or third-party vendors and must be purchased and installed separately from the installation of Adaptive Server. For more information on directory services currently supported by Adaptive Server, see the configuration documentation for your platform. See also "Directory Services" on page 1-15.

Configure and Test Client Connections

A successful client connection depends on the coordination of Adaptive Server, the client software, and network products. If you are using one of the network protocols installed with Adaptive Server, see the configuration documentation for your platform for information about testing network connections. If you are using a different network protocol, follow the instructions that are included with the network product. You can also use "ping" utilities that are included with Sybase connectivity products to test client connections with Adaptive Server. For a general description of how clients connect to Adaptive Server, see "Connecting to Adaptive Server" on page 1-14. See also the configuration documentation for your platform for details about the name and contents of the interfaces file.

Allocating Physical Resources

Allocating physical resources is the process of giving Adaptive Server the memory, disk space, worker processes, and CPU power required to achieve your performance and recovery goals. When installing a new server, every System Administrator must make

decisions about resource utilization. You will also need to reallocate Adaptive Server's resources if you upgrade your platform by adding new memory, disk controllers, or CPUs, or if the design of your database system changes. Or, early benchmarking of Adaptive Server and your applications can help you spot deficiencies in hardware resources that create performance bottlenecks.

See Chapter 11, "Overview of Disk Resource Issues," in this manual to understand the kinds of disk resources required by Adaptive Server. See also Chapter 14, "Configuring Memory," and Chapter 16, "Managing Multiprocessor Servers," for information about memory and CPU resources.

The following sections provide helpful pointers in determining physical resource requirements.

Dedicated vs. Shared Servers

The first step in planning Adaptive Server resources is understanding the resources required by **other** applications running on the same machine. In most cases, System Administrators dedicate an entire machine for Adaptive Server use. This means that only the operating system and network software consume resources that otherwise might be reserved for Adaptive Server. On a shared system, other applications, such as Adaptive Server client programs or print servers, run on the same machine as Adaptive Server. It can be difficult to calculate the resources available to Adaptive Server on a shared system, because the types of programs and their pattern of use may change over time.

In either case, it is the System Administrator's responsibility to take into account the resources used by operating systems, client programs, windowing systems, and so forth when configuring resources for Adaptive Server. Configure Adaptive Server to use only the resources that are available to it. Otherwise, the server may perform poorly or fail to start.

Decision Support and OLTP Applications

Adaptive Server contains many features that optimize performance for OLTP, decision support, and mixed workload environments. However, you must determine in advance the requirements of your system's applications to make optimal use of these features.

For mixed workload systems, list the individual tables that you anticipate will be most heavily used for each type of application; this can help you achieve maximum performance for applications.

Advance Resource Planning

It is extremely important that you understand and plan resource usage in advance. In the case of disk resources, for example, after you initialize and allocate a device to Adaptive Server, that device cannot be used for any other purpose (even if Adaptive Server never fills the device with data). Likewise, Adaptive Server automatically reserves the memory for which it is configured, and this memory cannot be used by any other application.

The following suggestions can help you plan resource usage:

- For recovery purposes, it is **always** best to place a database's transaction log on a separate physical device from its data. See Chapter 21, "Creating and Managing User Databases."
- Consider mirroring devices that store mission-critical data. See Chapter 13, "Mirroring Database Devices." You may also consider using disk arrays and disk mirroring for Adaptive Server data if your operating system supports these features.
- If you are working with a test Adaptive Server, it is sometimes easier to initialize database devices as operating system files, rather than raw devices, for convenience. Adaptive Server supports either raw partitions or certified file systems for its devices.
- Keep in mind that changing configuration options can affect the way Adaptive Server consumes physical resources. This is especially true of memory resources. See Chapter 17, "Setting Configuration Parameters," for details about the amount of memory used by individual parameters.

Operating System Configuration

Once you have determined the resources that are available to Adaptive Server and the resources you require, configure these physical resources at the operating system level:

- If you are using raw partitions, initialize the raw devices to the sizes required by Adaptive Server. Note that, if you initialize a raw device for Adaptive Server, that device cannot be used for

any other purpose (for example, to store operating system files). Ask your operating system administrator for assistance in initializing and configuring raw devices to the required sizes.

- Configure the number of network connections. Make sure that the machine on which Adaptive Server runs can actually support the number of connections you configure. See your operating system documentation.
- Additional configuration may be required for your operating system and the applications that you use. Read the installation documentation for your platform to understand the Adaptive Server operating system requirements. Also read your client software documentation or consult with your engineers to understand the operating system requirements for your applications.

Backup and Recovery

Making regular backups of your databases is crucial to the integrity of your database system. Although Adaptive Server automatically recovers from system crashes (for example, power outages) or server crashes, only **you** can recover from data loss caused by media failure. Follow the basic guidelines below for backing up your system.

The following chapters describe how to develop and implement a backup and recovery plan:

- Chapter 26, “Developing a Backup and Recovery Plan”
- Chapter 27, “Backing Up and Restoring User Databases”
- Chapter 28, “Restoring the System Databases”
- Chapter 29, “Managing Free Space with Thresholds”

Keep Up-to-Date Backups of Master

Backing up the *master* database is the cornerstone of any backup and recovery plan. The *master* database contains details about the structure of your entire database system. Its keeps track of the Adaptive Server databases, devices, and device fragments that make up those databases. Because Adaptive Server needs this information during recovery, it is crucial to maintain an up-to-date backup copy of the *master* database at all times.

To ensure that your backup of *master* is always up to date, back up the database after each command that affects disks, storage,

databases, or segments. This means you should back up *master* after performing any of the following procedures:

- Creating or deleting databases
- Initializing new database devices
- Adding new dump devices
- Using any device mirroring command
- Creating or dropping system stored procedures, if they are stored in *master*
- Creating, dropping, or modifying a segment
- Adding new Adaptive Server logins

To back up *master* to a tape device, start **isql** and enter the command:

```
dump database master to "tape_device"
```

where *tape_device* is the name of the tape device (for example, */dev/rmt0*).

Keep Offline Copies of System Tables

In addition to backing up *master* regularly, keep offline copies of the contents of the following system tables: *sysdatabases*, *sysdevices*, *sysusages*, *sysloginroles*, and *syslogins*. Do this by using the **bcp** or **wbcp** utility, described in the *Utility Programs* manual for your platform, and by storing a printed copy of the contents of each system table. You can create a printed copy by printing the output of the following queries:

```
select * from sysusages order by vstart
select * from sysdatabases
select * from sysdevices
select * from sysloginroles
select * from syslogins
```

If you have copies of these tables, and a hard disk crash or some other disaster makes your database unusable, you will be able to use the recovery procedures described in Chapter 28, “Restoring the System Databases.”

You should also keep copies of all data definition language (DDL) scripts for user objects, as described under “Keeping Records” on page 3-11.

Automate Backup Procedures

Creating an automated backup procedure takes the guesswork out of performing backups and makes the procedure easier and quicker to perform. Automating backups can be as simple as using an operating system script or a utility (for example, the UNIX **cron** utility) to perform the necessary backup commands. Or you can automate the procedure further using thresholds, which are discussed in Chapter 29, "Managing Free Space with Thresholds."

Although the commands required to create an automated script vary, depending on the operating system you use, all scripts should accomplish the same basic steps:

1. Start **isql** and dump the transaction log to a holding area (for example, a temporary file).
2. Rename the dump file to a name that contains the dump date, time, and database name.
3. Make a note about the new backup in a history file.
4. Record any errors that occurred during the dump in a separate error file.
5. Automatically send mail to the System Administrator for any error conditions.

Verify Data Consistency Before Backing Up a Database

Having backups of a database sometimes is not enough—you must have consistent, **accurate** backups (especially for *master*). If you back up a database that contains internal errors, the database will have the same errors when you restore it.

Using the **dbcc** commands, you can check a database for errors before backing it up. Always use **dbcc** commands to verify the integrity of a database before dumping it. If **dbcc** detects errors, correct them before dumping the database.

Over time, you can begin to think of running **dbcc** as insurance for your databases. If you discovered few or no errors while running **dbcc** in the past, you may decide that the risk of database corruption is small and that **dbcc** needs to be run only occasionally. Or, if the consequences of losing data are too high, you should continue to run **dbcc** commands each time you back up a database.

➤ ***Note***

For performance considerations, many sites choose to run **dbcc** checks outside of peak hours or on separate servers.

See Chapter 25, "Checking Database Consistency," for information about the **dbcc** command.

Monitor the Log Size

When the transaction log becomes nearly full, it may be impossible to use standard procedures to dump transactions and reclaim space. The System Administrator should monitor the log size and perform regular transaction log dumps (in addition to regular database dumps) to make sure this situation never occurs. Use the preferred method of setting up a threshold stored procedure that notifies you (or dumps the log) when the log reaches a certain capacity. See Chapter 29, "Managing Free Space with Thresholds," for information about using threshold procedures. It is also good to dump the transaction log just prior to doing a full database dump in order to shorten the time required to dump and load the database.

You can also monitor the space used in the log segment manually by using the **sp_helpsegment** stored procedure, as described under "Getting Information About Segments" on page 23-16.

Ongoing Maintenance and Troubleshooting

In addition to making regularly scheduled backups, the System Administrator performs the following maintenance activities throughout the life of a server.

Starting and Stopping Adaptive Server

Most System Administrators automate the procedure for starting Adaptive Server to coincide with the start-up of the server machine. This can be accomplished by editing operating system start-up scripts or through other operating system procedures. See the configuration documentation for your platform to determine how to start and stop Adaptive Server.

Viewing and Pruning the Error Log

You should examine the contents of the error log on a regular basis to determine if any serious errors have occurred. You can also use operating system scripts to scan the error log for particular messages and to notify the System Administrator when specific errors occur. Checking the error log regularly helps you determine whether there are continuing problems of the same nature or whether a particular database device is going bad. See Chapter 4, “Diagnosing System Problems,” for more information about error messages and their severity.

The error log file can grow large over time, since Adaptive Server appends informational and status messages to it each time it starts up. You can periodically “prune” the log file by opening the file and deleting old records. Keeping the log file to a manageable size saves disk space and makes it easier to locate current errors.

Keeping Records

Keeping records about your Adaptive Server system is an important part of your job as a System Administrator. Accurate records of changes and problems that you have encountered can be a valuable reference when you are contacting Sybase Technical Support or recovering databases. More important, they can provide vital information for administrators who manage the Adaptive Server system in your absence. The following sections describe the kinds of records that are most valuable to maintain.

Contact Information

Maintain a list of contact information for yourself as well as the System Security Officer, operator, and database owners on your system. Also, record secondary contacts for each role. Make this information available to all Adaptive Server users so that the appropriate contacts receive enhancement requests and problem reports.

Configuration Information

Ideally, you should create databases, create database objects, and configure Adaptive Server using script files that you later store in a safe place. Storing the script files use makes it possible to re-create

your entire system in the event of a disaster. It also allows you to re-create database systems quickly on new hardware platforms for evaluation purposes. If you use a third-party tool to perform system administration, remember to generate equivalent scripts after performing administration tasks.

Consider recording the following kinds of information:

- Commands used to create databases and database objects (DDL scripts)
- Commands that add new Adaptive Server logins and database users
- The current Adaptive Server configuration file, as described in "Using sp_configure with a Configuration File" on page 17-11
- The names, locations, and sizes of all files and raw devices initialized as database devices

It is also helpful to maintain a dated log of all changes to the Adaptive Server configuration. Mark each change with a brief description of when and why you made the change, as well a summary of the end result.

Maintenance Schedules

Keep a calendar of regularly scheduled maintenance activities. Such a calendar should list any of the procedures you perform at your site:

- Using **dbcc** to check database consistency
- Backing up user and system databases
- Monitoring the space left in transaction logs (if this is not done automatically)
- Dumping the transaction log
- Examining the error log contents for Adaptive Server, Backup Server™, and Adaptive Server Monitor™.
- Running the **update statistics** command (see Chapter 10, "Managing Statistics to Improve Performance," in the *Performance and Tuning Guide*)
- Examining auditing information, if the auditing option is installed
- Recompiling stored procedures
- Monitoring the resource utilization of the server machine

System Information

Record information about the hardware and operating system on which you run Adaptive Server. This can include:

- Copies of operating system configuration files or start-up files
- Copies of network configuration files (for example, the *hosts* and *services* files)
- Names and permissions for the Adaptive Server executable files and database devices
- Names and locations of the tape devices used for backups
- Copies of operating system scripts or programs for automated backups, starting Adaptive Server, or performing other administration activities

Disaster Recovery Plan

Consolidate the basic backup and recovery procedures, the hints provided in “Backup and Recovery” on page 3-7, and your personal experiences in recovering data into a concise list of recovery steps tailored to your system. This can be useful to both yourself and to other System Administrators who may need to recover a production system in the event of an emergency.

Getting More Help

The amount of new information that System Administrators must learn may seem overwhelming. There are several software tools that can help you learn and facilitate basic administration tasks. These include Adaptive Server Monitor, used for monitoring server performance and other activities, and Sybase Central, which simplifies many administration tasks. Also available are many third-party software packages designed to help System Administrators manage daily maintenance activities.

4 Diagnosing System Problems

This chapter discusses diagnosing and fixing system problems. Topics include:

How Adaptive Server Uses Error Messages to Respond to System Problems

When Adaptive Server encounters a problem, it displays information—in an error message that describes whether the problem is caused by the user or the system—about the problem, how serious it is, and what you can do to fix it. The error message consists of:

- A **message number**, which uniquely identifies the error message
- A **severity level number** between 10 and 24, which indicates the type and severity of the problem
- An **error state number**, which allows unique identification of the line of Adaptive Server code at which the error was raised
- An **error message**, which tells you what the problem is, and may suggest how to fix it

For example, this is what happens if you try to access a table that does not exist:

```
select * from publisher

Msg 208, Level 16, State 1:
publisher not found. Specify owner.objectname or
use sp_help to check whether the object exists
(sp_help may produce lots of output).
```

In some cases, there can be more than one error message for a single query. If there is more than one error in a batch or query, Adaptive

Server usually reports only the first one. Subsequent errors are reported the next time you execute the batch or query.

The error messages are stored in *master..sysmessages*, which is updated with each new release of Adaptive Server. Here are the first few rows (from an Adaptive Server with us_english as the default language):

```
select error, severity, description
from sysmessages
where error >=101 and error <=106
and langid is null
```

```
error severity description
----- -------- ----------------------------------------------------
  101       15 Line %d: SQL syntax error.
  102       15 Incorrect syntax near '%.*s'.
  103       15 The %S_MSG that starts with '%.*s' is too long.
               Maximum length is %d.
  104       15 Order-by items must appear in the select-list if
               the statement contains set operators.
  105       15 Unclosed quote before the character string '%.*s'.
  106       16 Too many table names in the query. The maximum
               allowable is %d.

(6 rows affected)
```

You can generate your own list by querying *sysmessages*. Here is some additional information for writing your query:

- If your server supports more than one language, *sysmessages* stores each message in each language. The column *langid* is NULL for us_english and matches the *syslanguages.langid* for other languages installed on the server. For information about languages on your server, use **sp_helplanguage.**
- The *dlevel* column in *sysmessages* is currently unused.
- The *sqlstate* column stores the SQLSTATE value for error conditions and exceptions defined in ANSI SQL92.
- Message numbers 17000 and greater are system procedure error messages and message strings.

Error Messages and Message Numbers

The combination of message number (*error*) and language ID (*langid*) uniquely identifies each error message. Messages with the same message number but different language IDs are translations.

```
select error, description, langid
from sysmessages
where error = 101
error description                              langid
----- ---------------------------------------- ------
  101 Line %d: SQL syntax error.                 NULL
  101 Ligne %1!: erreur de syntaxe SQL.             1
  101 Zeile %1!: SQL Syntaxfehler.                  2

(3 rows affected)
```

The error message text is a description of the problem. The descriptions often include a line number, a reference to a kind of database object (a table, column, stored procedure, and so forth), or the name of a particular database object.

In the *description* field of *sysmessages*, a percent sign (%) followed by a character or character string serves as a placeholder for these pieces of data, which Adaptive Server supplies when it encounters the problem and generates the error message. "%d" is a placeholder for a number; "%S_MSG" is a placeholder for a kind of database object; "%.*s"—all within quotes—is a placeholder for the name of a particular database object. Table 4-1 lists placeholders and what they represent.

For example, the *description* field for message number 103 is:

```
The %S_MSG that starts with '%.*s' is too long.
Maximum length is %d.
```

The actual error message as displayed to a user might be:

```
The column that starts with 'title' is too long.
Maximum length is 80.
```

For errors that you report to Technical Support, it is important that you include the numbers, object types, and object names. (See "Reporting Errors" on page 4-12.)

Variables in Error Message Text

Table 4-1 explains the symbols that appear in the text provided with each error message explanation:

Table 4-1: Error text symbols key

Symbol	Stands For
%d, %D	Decimal number

Table 4-1: Error text symbols key (continued)

Symbol	Stands For
%x,%X,%.*x,%lx, %04x, %08lx	Hexadecimal number
%s	Null-terminated string
%.*s, %*s, %*.s	String, usually the name of a particular database object
%S_*type*	Adaptive Server-defined structure
%c	Single character
%f	Floating-point number
%ld	Long decimal
%lf	Double floating-point number

Adaptive Server Error Logging

Error messages from Adaptive Server are sent only to the user's screen.

The backtrace from fatal error messages (severity levels 19 and higher) and error messages from the kernel are also sent to an error log file. The name of this file varies; see the configuration documentation for your platform or the *Utility Programs* manual for your platform.

➤ ***Note***

The error log file is owned by the user who installed Adaptive Server (or the person who started Adaptive Server after an error log was removed). Permissions or ownership problems with the error log at the operating system level can block successful start-up of Adaptive Server.

Adaptive Server creates an error log for you if one does not already exist. You specify the location of the error log at start-up with the *errorlogfile* parameter in the runserver file or at the command line. The Sybase installation utility configures the runserver file with *$SYBASE/install* as the location of the error log if you do not choose an alternate location during installation. If you do not specify the location in the runserver file or at the command line, the location of the error log is the directory from which you start Adaptive Server. For more information about specifying the location of the error log,

see the the *Utility Programs* manual for your platform manual for your platform.

➤ ***Note***

Always start Adaptive Server from the same directory, or with the runserver file or the error log flag, so that you can locate your error log.

Each time you start a server, messages in the error log provide information on the success (or failure) of the start and the recovery of each database on the server. Subsequent fatal error messages and all kernel error messages are appended to the error log file. If you need to reduce the size of the error log by deleting old or unneeded messages, you must "prune" the log while Adaptive Server is shut down.

Error Log Format

Entries in the error log include the following information:

- The engine involved for each log entry. The engine number is indicated by a 2-digit number. If only one engine is online, the display is "00."
- The family ID of the originating thread:
  - In serial processing, the display is "00000."
  - In **parallel processing**, the display is the server process ID number of the parent of the originating thread.
- The server process ID of the originating thread:
  - In serial processing, this is the server process ID number of the thread that generated the message. If the thread is a system task, then the display is "00000."
  - In parallel processing, this is the server process ID number of the originating thread.
- The date, displayed in the format *yyyy/mm/dd*, which allows you to sort error messages by date.
- The time, displayed in 24-hour format, which includes seconds and hundredths of a second.
- The word "server" or "kernel." This entry is for Sybase Technical Support use only.
- The error message itself.

Figure 4-1 shows two examples of a line from an error log:

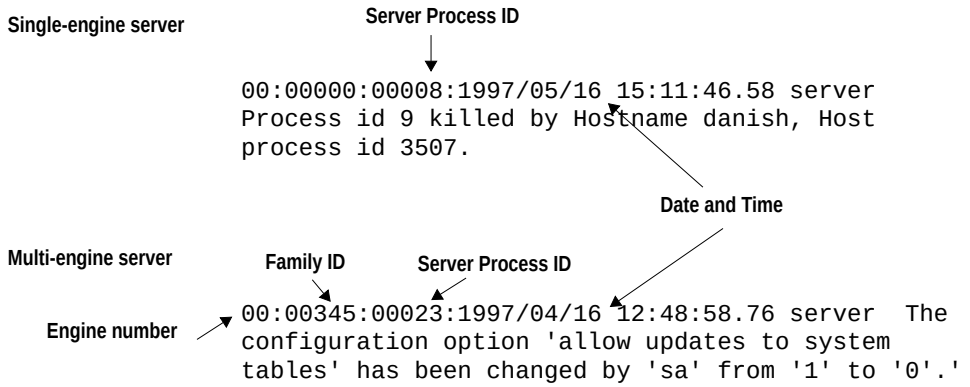

Figure 4-1: Error log format

Severity Levels

The severity level of a message indicates information about the type and severity of the problem that Adaptive Server has encountered. For maximum integrity, when Adaptive Server responds to error conditions, it displays messages from *sysmessages*, but takes action according to an internal table. A few corresponding messages differ in severity levels, so you may occasionally notice a difference in expected behavior if you are developing applications or procedures that refer to Adaptive Server messages and severity levels.

◆ ***WARNING!***

You can create your own error numbers and messages based on Adaptive Server error numbers (for example, by adding 20,000 to the Adaptive Server value). However, you cannot alter the Adaptive Server-supplied system messages in the *sysmessages* system table.

You can add user-defined error messages to *sysusermessages* with **sp_addmessage**. See the *Adaptive Server Reference Manual*.

Users should inform the System Administrator whenever problems that generate severity levels of 17 and higher occur. The System

Administrator is responsible for resolving them and tracking their frequency.

If the problem has affected an entire database, the System Administrator may have to use the database consistency checker (**dbcc**) to determine the extent of the damage. The **dbcc** may identify some objects that have to be removed. It can repair some damage, but the database may have to be reloaded.

For more information, refer to the following chapters:

- **dbcc** is discussed in Chapter 25, "Checking Database Consistency."
- Loading a user database is discussed in Chapter 27, "Backing Up and Restoring User Databases."
- Loading system databases is discussed in Chapter 28, "Restoring the System Databases."

The following sections discuss each severity level.

Levels 10–18

Error messages with severity levels 10–16 are generated by problems that are caused by user errors. These problems can always be corrected by the user. Severity levels 17 and 18 do not terminate the user's session.

Error messages with severity levels 17 and higher should be reported to the System Administrator or Database Owner.

Level 10: Status Information

Messages with severity level 10 are not errors at all. They provide additional information after certain commands have been executed and, typically, do not display the message number or severity level. For example, after a **create database** command has been run, Adaptive Server displays a message telling the user how much of the requested space has been allocated for the new database.

In **isql**, severity level 10 (status or informational) messages do not display a message number or severity level. In Open Client™ applications, Adaptive Server returns 0 for severity level 10.

Level 11: Specified Database Object Not Found

Messages with severity level 11 indicate that Adaptive Server cannot find an object that was referenced in the command.

This is often because the user has made a mistake in typing the name of a database object, because the user did not specify the object owner's name, or because of confusion about which database is current. Check the spelling of the object names, use the owner names if the object is not owned by you or "dbo," and make sure you are in the correct database.

Level 12: Wrong Datatype Encountered

Messages with severity level 12 indicate a problem with datatypes. For example, the user may have tried to enter a value of the wrong datatype in a column or to compare columns of different and incompatible datatypes.

To correct comparison problems, use the **convert** function with **select**. For information on **convert**, see the *Adaptive Server Reference Manual* or the *Transact-SQL User's Guide*.

Level 13: User Transaction Syntax Error

Messages with severity level 13 indicate that something is wrong with the current user-defined transaction. For example, you may have issued a **commit transaction** command without having issued a **begin transaction** or you may have tried to roll back a transaction to a savepoint that has not been defined (sometimes there may be a typing or spelling mistake in the name of the savepoint).

Severity level 13 can also indicate a deadlock, in which case the deadlock victim's process is rolled back. The user must restart his or her command.

Level 14: Insufficient Permission to Execute Command

Messages with severity level 14 mean that you do not have the necessary permission to execute the command or access the database object. You can ask the owner of the database object, the owner of the database, or the System Administrator to grant you permission to use the command or object in question.

Level 15: Syntax Error in SQL Statement

Messages with severity level 15 indicate that the user has made a mistake in the syntax of the command. The text of these error

messages includes the line numbers on which the mistake occurs and the specific word near which it occurs.

Level 16: Miscellaneous User Error

Most error messages with severity level 16 reflect that the user has made a nonfatal mistake that does not fall into any of the other categories. Severity level 16 and higher can also indicate software or hardware errors.

For example, the user may have tried to update a view in a way that violates the restrictions. Another error that falls into this category is unqualified column names in a command that includes more than one table with that column name. Adaptive Server has no way to determine which one the user intends. Check the command syntax and working database context.

Messages that ordinarily have severities greater than 16 will show severity 16 when they are raised by **dbcc checktable** or **dbcc checkalloc** so that checks can continue to the next object. When you are running the **dbcc** utility, check the *Error Messages* manual for information about error messages between 2500 and 2599 with a severity level of 16.

➤ ***Note***

Levels 17 and 18 are usually not reported in the error log. Users should be instructed to notify the System Administrator when level 17 and 18 errors occur.

Level 17: Insufficient Resources

Error messages with severity level 17 mean that the command has caused Adaptive Server to run out of resources or to exceed some limit set by the System Administrator. You can continue with the work you are doing, although you may not be able to execute a particular command.

These system limits include the number of databases that can be open at the same time and the number of connections allowed to Adaptive Server. They are stored in system tables and can be checked with **sp_configure**. See Chapter 17, “Setting Configuration Parameters,” for more information on changing configuration variables.

The Database Owner can correct the level 17 error messages indicating that you have run out of space. Other level 17 error messages should be corrected by the System Administrator.

Level 18: Non-Fatal Internal Error Detected

Error messages with severity level 18 indicate some kind of internal software bug. However, the command runs to completion, and the connection to Adaptive Server is maintained. You can continue with the work you are doing, although you may not be able to execute a particular command. An example of a situation that generates severity level 18 is Adaptive Server detecting that a decision about the access path for a particular query has been made without a valid reason.

Since problems that generate such messages do not keep users from their work, users tend not to report them. Users should be instructed to inform the System Administrator every time an error message with this severity level (or higher) occurs so that the System Administrator can report them.

Severity Levels 19–26

Fatal problems generate error messages with severity levels 19 and higher. They break the user's connection to Adaptive Server (some of the higher severity levels shut down Adaptive Server). To continue working, the user must restart the client program.

When a fatal error occurs, the process freezes its state before it stops, recording information about what was happening. It is then killed and disappears.

When the user's connection is broken, he or she may or may not be able to reconnect and resume working. Some problems with severity levels in this range affect only one user and one process. Others affect all the processes in the database. In some cases, it will be necessary to restart Adaptive Server. These problems do not necessarily damage a database or its objects, but they can. They may also result from earlier damage to a database or its objects. Other problems are caused by hardware malfunctions.

A backtrace of fatal error messages from the kernel is directed to the error log file, where the System Administrator can review it.

Level 19: Adaptive Server Fatal Error in Resource

Error messages with severity level 19 indicate that some non-configurable internal limit has been exceeded and that Adaptive Server cannot recover gracefully. You must reconnect to Adaptive Server.

Level 20: Adaptive Server Fatal Error in Current Process

Error messages with severity level 20 indicate that Adaptive Server has encountered a bug in a command. The problem has affected only the current process, and it is unlikely that the database itself has been damaged. Run **dbcc** diagnostics. You must reconnect to Adaptive Server.

Level 21: Adaptive Server Fatal Error in Database Processes

Error messages with severity level 21 indicate that Adaptive Server has encountered a bug that affects all the processes in the current database. However, it is unlikely that the database itself has been damaged. Restart Adaptive Server and run the **dbcc** diagnostics. You must reconnect to Adaptive Server.

Level 22: Adaptive Server Fatal Error: Table Integrity Suspect

Error messages with severity level 22 indicate that the table or index specified in the message was previously damaged by a software or hardware problem.

The first step is to restart Adaptive Server and run **dbcc** to determine whether other objects in the database are also damaged. Whatever the report from **dbcc** may be, it is possible that the problem is in the cache only and not on the disk itself. If so, restarting Adaptive Server will fix the problem.

If restarting does not help, then the problem is on the disk as well. Sometimes, the problem can be solved by dropping the object specified in the error message. For example, if the message tells you that Adaptive Server has found a row with length 0 in a nonclustered index, the table owner can drop the index and re-create it.

Adaptive Server takes any pages or indexes offline that it finds to be suspect during recovery. Use **sp_setsuspect_granularity** to determine whether recovery marks an entire database or only individual pages

as suspect. See **sp_setsuspect_granularity** in the *Adaptive Server Reference Manual* for more information.

You must reconnect to Adaptive Server.

Level 23: Fatal Error: Database Integrity Suspect

Error messages with severity level 23 indicate that the integrity of the entire database is suspect due to previous damage caused by a software or hardware problem. Restart Adaptive Server and run **dbcc** diagnostics.

Even when a level 23 error indicates that the entire database is suspect, the damage may be confined to the cache, and the disk itself may be fine. If so, restarting Adaptive Server with **startserver** will fix the problem.

Level 24: Hardware Error or System Table Corruption

Error messages with severity level 24 reflect some kind of media failure or (in rare cases) the corruption of *sysusages*. The System Administrator may have to reload the database. It may be necessary to call your hardware vendor.

Level 26: Rule Error

Error messages with severity level 26 reflect that an internal locking or synchronization rule was broken. You must shut down and restart Adaptive Server.

Reporting Errors

When you report an error, include:

- The message number, level number, and state number.
- Any numbers, database object types, or database object names that are included in the error message.
- The context in which the message was generated, that is, which command was running at the time. You can help by providing a hard copy of the backtrace from the error log.

Backup Server Error Logging

Like Adaptive Server, Backup Server creates an error log if one does not already exist.You specify the location of the error log at start-up with the *error_log_file* parameter in the runserver file or at the command line. The Sybase installation utility configures the runserver file with *$SYBASE/install* as the location of the error log if you do not choose an alternate location during installation. If you do not specify the location in the runserver file or at the command line, the location of the error log is the directory from which you start Backup Server. For more information about specifying the location of the error log, see the *Utility Programs* manual for your platform manual for your platform.

Backup Server error messages are in the form:

```
MMM DD YYY: Backup Server:N.N.N.N: Message Text
```

Backup Server message numbers consist of 4 integers separated by periods, in the form N.N.N.N. Messages in the form N.N.N are sent by Open Server™.

The four components of a Backup Server error message are *major.minor.severity.state*:

- The *major* component generally indicates the functional area of the Backup Server code where the error occurred:
  - 1 – System errors
  - 2 – Open Server event errors
  - 3 – Backup Server remote procedure call errors
  - 4 – I/O service layer errors
  - 5 – Network data transfer errors
  - 6 – Volume handling errors
  - 7 – Option parsing errors

  Major error categories 1–6 may result from Backup Server internal errors or a variety of system problems. Major errors in category 7 are almost always due to problems in the options you specified in your dump or load command.
- *minor* numbers are assigned in order within a major category.
- *severity* is:
  - 1 – Informational, no user action necessary.

  - 2, 3 – An unexpected condition, possibly fatal to the session, has occurred. The error may have occurred with usage, environment, or internal logic, or any combination of these factors.
  - 4 – An unexpected condition, fatal to the execution of the Backup Server, has occurred. The Backup Server must exit immediately.
- *state* codes have a one-to-one mapping to instances of the error report within the code. If you need to contact Technical Support about Backup Server errors, the state code helps determine the exact cause of the error.

Killing Processes

A process is a unit of execution carried out by Adaptive Server. Each process is assigned a unique process identification number when it starts, this number is called a *spid*. These numbers are stored, along with other information about each process, in *master..sysprocesses*. Processes running in a parallel processes environment create child processes, each of which has its own *spid*s. Several processes create and assign *spids*: booting Adaptive Server, login tasks, checkpoints, the housekeeper task, and so on. You can see most of the information by running **sp_who**.

Running **sp_who** on a single-engine server shows the **sp_who** process running and all other processes that are "runnable" or in one of the sleep states. In multi-engine servers, there can be a process running for each engine.

The **kill** command gets rid of an ongoing process. The most frequent reason for killing a process is that it interferes with other users and the person responsible for running it is not available. The process may hold locks that block access to database objects, or there may be many sleeping processes occupying the available user connections. A System Administrator can kill processes that are:

- Waiting for an alarm, such as a **waitfor** command
- Waiting for network sends or receives
- Waiting for a lock
- Waiting for synchronization messages from another process in a family
- Most running or "runnable" processes

Adaptive Server allows you to kill processes only if it can cleanly roll back any uncompleted transactions and release all system resources that are used by the process. For processes that are part of a family, killing any of the child processes will also kill all other processes in the family. However, it is easiest to kill the parent process. For a family of processes, the **kill** command is detected more quickly if the status of the child processes is `sync sleep` (see below).

Table 4-2 shows the values that **sp_who** reports and when the **kill** command takes effect.

Table 4-2: Status values reported by sp_who

Status		Effects of *kill* Command
`recv sleep`	Waiting on a network read	Immediate.
`send sleep`	Waiting on a network send	Immediate.
`alarm sleep`	Waiting on an alarm such as `waitfor delay "10:00"`	Immediate.
`lock sleep`	Waiting on a lock acquisition	Immediate.
`sync sleep`	Waiting on a synchronization message from another process in the family.	Immediate. Other processes in the family must also be brought to state in which they can be killed
`sleeping`	Waiting on a disk I/O, or some other resource. Probably indicates a process that is running, but doing extensive disk I/O	Killed when it "wakes up," usually immediate; a few sleeping processes do not wake up and require a Server reboot to clear.
`runnable`	In the queue of runnable processes	Immediate.
`running`	Actively running on one of the server engines	Immediate.
`infected`	Server has detected serious error condition; extremely rare	**kill** command not recommended. Server reboot probably required to clear process.
`background`	A process, such as a threshold procedure, run by Adaptive Server rather than by a user process	Immediate; use **kill** with extreme care. Recommend a careful check of *sysprocesses* before killing a background process.

Table 4-2: Status values reported by sp_who (continued)

Status		Effects of *kill* Command
log suspend	Processes suspended by reaching the last-chance threshold on the log	Immediate.

Only a System Administrator can issue the **kill** command; permission to use it cannot be transferred.

The syntax is:

```
kill spid
```

You can kill only one process at a time, but you can perform a series of kill commands in a batch. For example:

```
1> kill 7
2> kill 8
3> kill 9
4> go
```

A **kill** command is not reversible and cannot be included in a user-defined transaction. *spid* must be a numeric constant; you cannot use a variable. Here is some sample output from **sp_who**:

```
fid   spid  status     loginame     origname    hostname blk     dbname
      cmd
----  ----- --------- --------     ---------   -------  ----    -------
-     ----------------
0     1     recv sleep howard       howard      svr30eng0    master
      AWAITING COMMAND
0     2     sleeping   NULL         NULL                0       master
      NETWORK HANDLER
0     3     sleeping   NULL         NULL                0       master
      DEADLOCK TUNE
0     4     sleeping   NULL         NULL                0       master
      MIRROR HANDLER
0     5     sleeping   NULL         NULL                0       master
      CHECKPOINT SLEEP
0     6     sleeping   NULL         NULL                0       master
      HOUSEKEEPER
0     7     recv sleep bill         bill        bigblue  0       master
      AWAITING COMMAND
0     8  recv sleep    wilbur       wilbur      hazel    0       master
      AWAITING COMMAND
0     9  recv sleep    joan         joan        luv2work 0       master
      AWAITING COMMAND
0     10 running       foote        foote       svr47hum0    master
      SELECT
(10 rows affected, return status = 0)
```

In the example above, processes 2–6 cannot be killed: they are system processes. The login name NULL and the lack of a host name identify them as system processes. You will always see NETWORK HANDLER, MIRROR HANDLER, HOUSEKEEPER, and CHECKPOINT SLEEP (or, rarely, CHECKPOINT). AUDIT PROCESS becomes activated if you enable auditing.

Processes 1, 8, 9, and 10 can be killed, since they have the status values "recv sleep," "send sleep," "alarm sleep," and "lock sleep."

In **sp_who** output, you cannot tell whether a process whose status is "recv sleep" belongs to a user who is using Adaptive Server and may be pausing to examine the results of a command or whether the process indicates that a user has restarted a PC or other terminal, and left a stranded process.You can learn more about a questionable process by querying the *sysprocesses* table for information. For example, this query shows the host process ID and client software used by process 8:

```
select hostprocess, program_name
    from sysprocesses
where spid = 8

 hostprocess program_name
 ----------- ---------------
 3993        isql
```

This query, plus the information about the user and host from the **sp_who** results, provides additional information for tracking down the process from the operating system level.

Using *sp_lock* to Examine Blocking Processes

In addition to **sp_who**, **sp_lock** can help identify processes that are blocking other processes. If the *blk* column in the **sp_who** report indicates that another process has been blocked while waiting to acquire locks, **sp_lock** can display information about the blocking process. For example, process 10 in the **sp_who** output above is blocked by process 7. To see information about process 7, execute:

```
sp_lock 7
```

For more information about locking in Adaptive Server, see the *Performance and Tuning Guide*.

Configuring Adaptive Server to Save SQL Batch Text

Occasionally a query or procedure causes Adaptive Server Monitor to hang. Users with the System Administrator role can configure Adaptive Server to give Adaptive Server Monitor access to the text of the currently executing SQL batch. Viewing the SQL text of long-running batches helps you debug hung processes or fine-tune long statements that are heavy resource consumers.

Adaptive Server must be configured to collect the SQL batch text and write it to shared memory, where the text can be read by Adaptive Server Monitor Server (the server component of Adaptive Server Monitor). The client requests might come from Monitor Viewer, which is a plug-in to Sybase Central, or other Adaptive Server Monitor Server applications.

Configuring Adaptive Server to save SQL batch text also allows you to view the current query plan in showplan format (as you would see after setting **showplan** on). You can view the current query plan from within Adaptive Server; see "Viewing the Query Plan of a SQL Statement" on page 4-22. SQL batches are viewable only through Adaptive Server Monitor Server. See the Adaptive Server Monitor Server documentation for more information about displaying the batch text.

Because the query or procedure you are viewing may be nested within a batch of SQL text, the *sysprocesses* table now includes columns for the line number, statement number and *spid* of a hung statement to view its query plan.

By default, Adaptive Server is not configured to save SQL batch text, so you must configure Adaptive Server to allocate memory for this feature. Adaptive Server Monitor access to SQL has no effect on performance if you have not configured any memory to save SQL batches.

Allocating Memory for Batch Text

You can configure the amount of the SQL text batch you want to save. When text saving is enabled, Adaptive Server copies the subsequent SQL text batches to memory shared with SQL Server Monitor. Because each new batch clears the memory for the connection and overwrites the previous batch, you can view only currently executing SQL statements. To save SQL text:

1. Configure the amount of SQL text retained in memory (see page 4-19).
2. Enable SQL Server to start saving SQL text (see page 4-20).

➤ ***Note***

You must have System Administration privileges to configure and save SQL text batches.

Configuring the Amount of SQL Text Retained in Memory

After installation, you must decide the maximum amount of SQL text that can be copied to shared memory. Consider the following to help you determine how much memory to allocate per user:

- SQL batches exceeding the allocated amount of memory are truncated without warning. If you do not allocate enough memory for the batch statements, the text you are interested in viewing might be the section of the batch that is truncated, as illustrated in Figure 4-2.

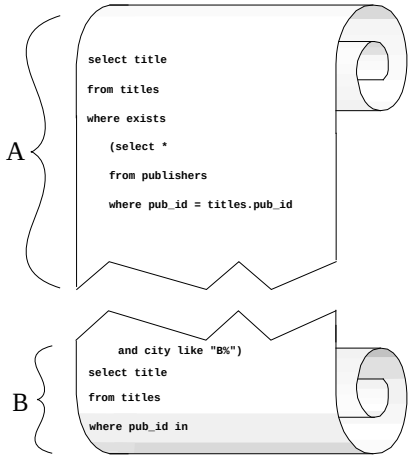

Figure 4-2: How SQL text is truncated if not enough memory is configured

For example, if you configure Adaptive Server to save the amount of text designated by bracket A in the illustration, but the statement that is running occurs in the text designated by

bracket B, Adaptive Server will not display the statement that is running.

- The more memory you allocate for SQL text from shared memory, the less chance the problem statement will be truncated from the batch copied to shared memory. However, Adaptive Server immediately rejects very large values because they do not leave enough memory for data and procedure caches.

Sybase recommends an initial value of 1024 bytes per user connection.

Use **sp_configure** with the **max SQL text monitored** configuration parameter to allocate shared memory:

```
sp_configure "max SQL text monitored", bytes_per_connection
```

where *bytes_per_connection* (the maximum number of bytes saved for each client connection) is between 0 (the default) and 2,147,483,647 (the theoretical limit).

Since memory for SQL text is allocated by Adaptive Server at start-up, you must restart Adaptive Server for this parameter to take effect.

The total memory allocated for the SQL text from shared memory is the product of *bytes_per_connection* multiplied by the number of user connections.

Enabling Adaptive Server to Start Saving SQL Text

After you allocate shared memory for SQL text, Adaptive Server saves a copy of each SQL batch whenever you enable an Adaptive Server Monitor event summary that includes SQL batches.

You may also have to reconfigure Adaptive Server Monitor's event buffer scan interval for SQL text. See the Adaptive Server Monitor documentation for more information.

SQL Commands Not Represented by Text

If you use Client-Library™ functions not represented by text (such as **ct_cursor** or **ct_dynamic**) to issue SQL commands, Client-Library encodes the information for efficiency, and Adaptive Server generally decodes and displays key command information. For example, if you open a cursor with **ct_cursor** and the command is running, the Adaptive Server Monitor event summary displays the cursor name and the cursor declare statement.

Table 4-3 lists a complete list of the Client-Library functions not represented by text:

Table 4-3: SQL commands not represented by text

Client-Library Routine	DB-Library Routine	Presentation Name	Presentation Data
ct_cursor	N / A	CLOSE_CURSOR	Cursor name, statement
ct_cursor	N / A	DECLARE_CURSOR	Cursor name, statement
ct_cursor	N / A	DELETE_AT_CURSOR	Cursor name, statement
ct_cursor	N / A	FETCH_CURSOR	Cursor name, statement
ct_fetch (when processing the results of **ct_cursor**)	N / A	FETCH_CURSOR	Cursor name, statement
ct_cursor CURSOR_ROWS, or **ct_cancel** when the connection has Client-Library cursors	N / A	CURSOR_INFO	Cursor name, statement
ct_cursor	N / A	OPEN_CURSOR	Cursor name, statement
ct_cursor	N / A	UPDATE_AT_CURSOR	Cursor name, statement
ct_command(CS_RPC_CMD) (default behavior)	**dbrpcinit** (only in version 10.0.1 or later)	DBLIB_RPC	RPC name
ct_dynamic	N / A	DYNAMIC_SQL	Dynamic statement name, statement
ct_command(CS_MSG_CMD	N / A	MESSAGE	None
ct_param	**dbrpcparam**	PARAM_FORMAT	None
ct_param	**dbrpcparam**	PARAMS	None
ct_command(CS_RPC_CMD) (only when a TDS version earlier than 5.0 is used)	**dbrpcparam** (in DB-Library version earlier than 10.0.1)	RPC	RPC name

For more information about SQL commands not represented by text, see your Open Client documentation.

Viewing the Query Plan of a SQL Statement

Use **sp_showplan** and the *spid* of the user connection in question to retrieve the query plan for the statement currently running on this connection. You can also use **sp_showplan** to view the query plan for a previous statement in the same batch.

Here is the syntax:

```
declare @batch int
declare @context int
declare @statement int
execute sp_showplan <spid_value>, @batch_id= @batch output,
@context_id= @context output, @stmt_num=@statement output
```

where *batch_id* is the unique number for a batch, *context_id* is a unique number for every procedure (or trigger) executed in the batch, and *stmt_num* is the number of the current statement within a batch. Adaptive Server uses the unique batch ID to synchronize the query plan with the batch text and other data retrieved by Adaptive Server Monitor.

➤ ***Note***

You must be a System Administrator to execute **sp_showplan**.

For example, to see the query plan for the current statement for *spid* 99:

```
declare @batch int
declare @context int
declare @statement int
exec sp_showplan 99, @batch output, @context output, @statement output
```

You can run the query plan procedure independently of Adaptive Server Monitor, regardless of whether or not Adaptive Server has allocated shared memory for SQL text.

Viewing Previous Statements

To see the query plan for the previous statement in the same batch, issue **sp_showplan** with the same values as the original query, but subtract one from the statement number. Using this method, you can view all the statements in the statement batch back to query number one.

Viewing a Nested Procedure

Although **sp_showplan** allows you to view the query plan for the current statement, the actual statement that is running may exist within a procedure (or within a nested chain of procedures) called from the original SQL batch. The following columns were added to the *sysprocesses* table to access these nested statements:

Table 4-4: Columns added to sysprocesses

Column	Datatype	Specifies
id	Integer	The object ID of the running procedure (or 0 if no procedure is running)
stmtnum	Integer	The current statement number within the running procedure (or the SQL batch statement number if no procedure is running)
linenum	Integer	The line number of the current statement within the running stored procedure (or the line number of the current SQL batch statement if no procedure is running)

This information is saved in *sysprocesses*, regardless of whether SQL text is enabled or any memory is allocated for SQL text.

Here is an example of a SQL statement that displays the *id*, *stmtnum*, and *linenum* columns of *sysprocesses*:

```
select id, stmtnum, linenum
from sysprocesses
where spid = spid_of_hung_session
```

➤ ***Note***

You do not need the **sa_role** to run this select statement.

Shutting Down Servers

A System Administrator can shut down Adaptive Server or Backup Server with the **shutdown** command. The syntax is:

```
shutdown [backup_server_name] [with {wait|nowait}]
```

The default for the **shutdown** command is **with wait.** That is, **shutdown** and **shutdown with wait** do exactly the same thing.

Shutting Down Adaptive Server

If you do not give a server name, **shutdown** shuts down the Adaptive Server you are using. When you issue a **shutdown** command, Adaptive Server:

1. Disables logins, except for System Administrators
2. Performs a checkpoint in each database, flushing pages that have changed from memory to disk
3. Waits for currently executing SQL statements or procedures to finish

In this way, **shutdown** minimizes the amount of work that automatic recovery must do when you restart Adaptive Server.

The **with nowait** option shuts down Adaptive Server immediately. User processes are aborted, and recovery may take longer after a **shutdown with nowait**. You can help minimize recovery time by issuing a **checkpoint** command before you issue a **shutdown with nowait** command.

Shutting Down a Backup Server

To shut down a Backup Server, give the Backup Server's name:

```
shutdown SYB_BACKUP
```

The default is **with wait**, so any dumps or loads in progress will complete before the Backup Server process halts. After you issue a **shutdown** command, no new dump or load sessions can be started on the Backup Server.

To see the names of the Backup Servers that are accessible from your Adaptive Server, execute **sp_helpserver**. Use the value in the *name* column in the **shutdown** command. You can shut down a Backup Server only if it is:

- Listed in *sysservers* on your Adaptive Server, and
- Listed in your local interfaces file.

Use **sp_addserver** to add a Backup Server to *sysservers*.

Checking for Active Dumps and Loads

To see the activity on your Backup Server before executing a **shutdown** command, run **sp_who** on the Backup Server:

```
SYB_BACKUP...sp_who
```

```
spid   status   loginame hostname   blk cmd
------ -------- -------- ---------- --- ----------------
     1 sleeping NULL     NULL       0   CONNECT HANDLER
     2 sleeping NULL     NULL       0   DEFERRED HANDLER
     3 runnable NULL     NULL       0   SCHEDULER
     4 runnable NULL     NULL       0   SITE HANDLER
     5 running  sa       heliotrope 0   NULL
```

Using *nowait* on a Backup Server

The **shutdown *backup_server* with nowait** command shuts down the Backup Server, regardless of current activity. Use it only in severe circumstances. It can leave your dumps or loads in incomplete or inconsistent states.

If you use **shutdown with nowait** during a log or database dump, check for the message indicating that the dump completed. If you did not receive this message, or if you are not sure whether the dump completed, your next dump should be a **dump database**, not a transaction dump. This guarantees that you will not be relying on possibly inconsistent dumps.

If you use **shutdown with nowait** during a load of any kind, and you did not receive the message indicating that the load completed, you may not be able to issue further **load transaction** commands on the database. Be sure to run a full database consistency check (**dbcc**) on the database before you use it. You may have to reissue the full set of load commands, starting with **load database.**

Learning About Known Problems

The release bulletin is a valuable resource for learning about known problems or incompatibilities with Adaptive Server and Backup Server. Reading the release bulletin in advance can save you the time and guesswork of troubleshooting known problems.

The Adaptive Server installation program also installs files that list all system problem reports (SPRs) and closed problem reports (CPRs) for Adaptive Server. Problem reports are organized by functional areas of the product. For example, a file named *cpr_bus* would contain a listing of closed (fixed) problem reports pertaining to the Backup Server, and the file *spr_bus* would contain a list of currently open problem reports for the Backup Server.

See the release bulletin to learn the location of CPR and SPR files.

Managing Users and Security

5 Security Administration

This chapter provides an overview of the security features available in Adaptive Server. Topics include:

Security Features Available in Adaptive Server

SQL Server release 11.0.6 passed the security evaluation by the National Security Agency (NSA) at the Class C2 criteria. (The requirements for the C2 criteria are given by the Department of Defense in DOD 52.00.28-STD, *Department of Defense Trusted Computer System Evaluation Criteria* [TCSEC], also known as the "Orange Book.")

The configuration of SQL Server release 11.0.6 that was evaluated at the C2 security level by the NSA in 1996 on the HP 9000 HP-UX BLS, 9.09+ platform is referred to as the **evaluated configuration**. Certain features of SQL Server, such as remote procedures and direct updates to system tables, were excluded from the evaluated configuration. Notes in the Adaptive Server documentation indicate particular features that were not included in the evaluated configuration. For a complete list of features that were excluded from the evaluated configuration, see Appendix A in the *SQL Server Installation and Configuration Guide for HP 9000 HP-UX BLS, 9.09+*.

Adaptive Server release 11.5 contains all of the security features included in SQL Server release 11.0.6 plus some new security features. Table 5-1 summarizes the major features.

Table 5-1: Major Security Features

Security Feature	Description
Discretionary Access Controls (DAC)	Provides access controls that give object owners the ability to restrict access to objects, usually with the **grant** and **revoke** commands. This type of control is dependent upon an object owner's discretion.
Identification and authentication controls	Ensures that only authorized users can log into the system.
Division of roles	Allows you to grant privileged roles to specified users so that only designated users can perform certain tasks. Adaptive Server has predefined roles, called "system roles," such as **System Administrator** and **System Security Officer**. In addition, Adaptive Server allows System Security Officers to define additional roles, called "user-defined roles."
Network-based security	Provides security services to authenticate users and protect data transmitted among machines on a network.
Auditing	Provides the capability to audit events such as logins, logouts, server boot operations, remote procedure calls, accesses to database objects, and all actions performed by a specific user or with a particular role active. In addition, Adaptive Server provides a single option to audit a set of server-wide security-relevant events.

General Process of Security Administration

Table 5-2 describes the major tasks that are required to administer Adaptive Server in a secure manner and refers you to the documentation that contains the instructions for performing each task.

Table 5-2: General process for security administration

Task	Description	See
1. Install Adaptive Server, including auditing.	This task includes preparing for installation, loading files from your distribution medium, performing the actual installation, and administering the physical resources that are required.	The the installation documentation for your platform

Table 5-2: General process for security administration (continued)

Task	Description	See
2. Set up a secure administrative environment.	This includes enabling auditing, granting roles to individual users to ensure individual accountability, and assigning login names to System Administrators and System Security Officers.	Chapter 6, "Managing Adaptive Server Logins and Database Users"
3. Add user logins to the server; add users to databases; establish groups and roles; set proxy aurhorizations.	Add logins, create groups, add users to databases, drop and lock logins, and assign initial passwords. Assign roles to users, create user-defined roles, and define role hierarchies and mutual exclusivity of roles.	Chapter 6, "Managing Adaptive Server Logins and Database Users"
4. Administer permissions for users, groups, and roles.	Grant and revoke permissions for certain SQL commands, executing certain system procedures, and accessing databases, tables, particular table columns, and views.	Chapter 7, "Managing User Permissions"
5. Administer the use of remote servers.	Establish and administer the access that is permitted between servers, add and drop remote server access, and map remote login names to local login names.	Chapter 9, "Managing Remote Servers" and the Adaptive Server installation and configuration documentation for your platform
6. Set up and maintain auditing.	Determine what is to be audited, audit the use of Adaptive Server, and use the audit trail to detect penetration of the system and misuse of resources.	Chapter 8, "Auditing" and the Adaptive Server installation and configuration documentation for your platform
7. Set up your installation for network-based security services.	Configure the server to use services, such as unified login, data confidentiality with encryption, data integrity, and determine security for remote procedures.	Chapter 10, "Using Network-Based Security"

Guidelines For Setting Up Security

Use the guidelines described in the following sections when you set up security on Adaptive Server.

Using the "sa" Login

When Adaptive Server is installed, a single login called "sa" is configured with the **System Administrator** and **System Security Officer** roles. This means that the "sa" login has unlimited power.

Use the “sa” login only during initial setup. Instead of allowing several users to use the “sa” account, establish individual accountability by assigning specific roles to individual administrators.

◆ ***WARNING!***

When logging in to Adaptive Server, do not use the -P option of isql to specify your password because another user may have an opportunity to see it.

Changing the “sa” Login Password

The “sa” login is configured initially with a “NULL” password. Use **sp_password** to change the password immediately after installation.

When To Enable Auditing

Enable auditing early in the administration process so that you have a record of privileged commands that are executed by System Security Officers and System Administrators. You might also want to audit commands that are executed by those with other special roles, such as operators when they dump and load databases.

Assigning Login Names

Assign Adaptive Server login names that are the same as their respective operating system login names. This makes logging in to Adaptive Server easier, simplifies management of server and operating system login accounts, and makes it easier to correlate the audit data generated by Adaptive Server with that of the operating system.

An Example of Setting Up Security

Suppose you have decided to assign special roles to the users listed in Table 5-3.

Table 5-3: Users to whom you will assign roles

Name	Role	Operating System Login Name
Rajnish Smith	**sso_role**	rsmith
Catharine Macar-Swan	**sa_role**	cmacar
Soshi Ikedo	**sa_role**	sikedo
Julio Rozanski	**oper_role**	jrozan

Table 5-4 shows the sequence of commands you might use to set up a secure operating environment for Adaptive Server, based upon the role assignments shown in Table 5-3. After logging in to the operating system, you would issue these commands using the initial "sa" account.

Table 5-4: Examples of commands used to set up security

Commands	Result
isql -Usa	Logs in to Adaptive Server as "sa". Both **sa_role** and **sso_role** are active.
sp_audit "security", "all", "all", "on" **sp_audit "all", "sa_role", "all", "on"** **sp_audit "all", "sso_role", "all", "on"'**	Sets auditing options for server-wide, security-relevant events and the auditing of all actions that have **sa_role** or **sso_role** active.
sp_configure "auditing", 1	Enables auditing. **Note:** Before you enable auditing, set up a threshold procedure for the audit trail and determine how to handle the transaction log in *sybsecurity*. For details, see Chapter 8, "Auditing."

Table 5-4: Examples of commands used to set up security (continued)

Commands	Result
sp_addlogin rsmith, js&2P3d, @fullname = "Rajnish Smith" **sp_addlogin cmacar, Fr3ds#1, @fullname = "Catharine Macar-Swan"** **sp_addlogin sikedo, mi5pd1s, @fullname = "Soshi Ikedo"** **sp_addlogin jrozan, w1seCrkr, @fullname = "Julio Rozanski"**	Adds logins and passwords for Rajnish, Catharine, Soshi, and Julio. A default database is not specified for any of these users, so their default database is *master*.
grant role sso_role to rsmith **grant role sa_role to sikedo** **grant role sa_role to cmacar** **grant role oper_role to jrozan**	Grants the **sso_role** to Rajnish, the **sa_role** to Soshi and Catharine, and the **oper_role** to Julio.
use sybsecurity **sp_changedbowner rsmith**	Grants access to the auditing database, *sybsecurity*, by making Rajnish, who is the System Security Officer, the database owner.
sp_locklogin sa,"lock"	Locks the "sa" login so that no one can log in as "sa". Individuals can assume only the roles that are configured for them. **Note:** Do not lock the "sa" login until you have granted individual users the **sa_role** and **sso_role** roles and have verified that the roles operate successfully.

Discretionary Access Controls

Owners of objects can grant access to those objects to other users. Object owners can also grant other users the ability to pass the access permission to other users. With Adaptive Server's discretionary access controls, you can give various kinds of permissions to users, groups, and roles with the **grant** command. Use the **revoke** command to rescind these permissions. The **grant** and **revoke** commands give users permission to execute specified commands and to access specified tables, views, and columns.

Some commands can be used at any time by any user, with no permission required. Others can be used only by users of a certain status such as a System Administrator and are not transferable.

The ability to assign permissions for the commands that can be granted and revoked is determined by each user's status (as System Administrator, Database Owner, or database object owner), and by whether or not a particular user has been granted a permission with the option to grant that permission to other users.

Discretionary access controls are discussed in Chapter 7, "Managing User Permissions."

Identification and Authentication Controls

Each Adaptive Server user is given a login account with a unique ID. All of that user's activity on the server can be attributed to a server user ID and audited.

Adaptive Server passwords are stored in the *master..syslogins* table in encrypted form. When you log into Adaptive Server from a client, you can choose client-side password encryption to encrypt your password before sending it over the network.

Adaptive Server allows users to be pre-authenticated by a security mechanism before they log in to the server. This capability, called **unified login**, enables a user to log in to several servers without having to supply a login name and password for every connection.

A System Security Officer can grant a user the ability to impersonate another user in the server. This ability, called **proxy authorization**, allows administrators to check permissions for a particular user or to perform maintenance on a user's database objects. Application servers can log in to the server and execute procedures and commands on behalf of several users.

Identification and authentication controls are discussed in Chapter 6, "Managing Adaptive Server Logins and Database Users." In addition, see "Using Proxy Authorization" in Chapter 7, "Managing User Permissions" and Chapter 9, "Managing Remote Servers."

Division of Roles

An important feature in Adaptive Server is the division of **roles**. The roles supported by Adaptive Server enable you to enforce and maintain individual accountability. Adaptive Server provides system roles, such as System Administrator and System Security

Officer, and user-defined roles, which are created by a System Security Officer.

Roles provide individual accountability for users performing operational and administrative tasks. Their actions can be audited and attributed to them.

Role Hierarchy

A System Security Officer can define role hierarchies such that if a user has one role, the user automatically has roles lower in the hierarchy. For example, the “chief_financial_officer” role might contain both the “financial_analyst” and the “salary_administrator” roles. The Chief Financial Analyst can perform all tasks and see all data that can be viewed by the Salary Administrators and Financial Analysts.

Mutual Exclusivity

Two roles can be defined to be mutually exclusive for:

- Membership – a single user cannot be granted both roles. For example, an installation might not want a single user to have both the “payment_requestor” and “payment_approver” roles to be granted to the same user.
- Activation – a single user cannot activate, or enable, both roles. For example, a user might be granted both the “senior_auditor” and the “equipment_buyer” roles, but the installation may not want to permit the user to have both roles enabled at the same time.

System roles, as well as user-defined roles, can be defined to be in a role hierarchy or to be mutually exclusive. For example, you might want a “super_user” role to contain the System Administrator, Operator, and “Tech Support” roles. In addition, you might want to define the System Administrator and System Security Officer roles to be mutually exclusive for membership; that is, a single user cannot be granted both roles.

See Chapter 6, “Creating and Assigning Roles to Users,” for information on administering and using roles.

Network-Based Security

Adaptive Server provides network-based security services that enable you to authenticate users and protect data transmitted among machines on a network.

In a distributed client/server computing environment intruders can view or tamper with confidential data. With Adaptive Server, you can use security services provided by third-party providers to authenticate users, encrypt data, and prevent data tampering.

Depending upon the security mechanism you choose, Adaptive Server allows you to use one or more of these security services:

- Unified login – use a security mechanism to authenticate users **once** without requiring them to supply a name and password every time they log in to an Adaptive Server.
- Message confidentiality – encrypt data over the network.
- Mutual authentication – use the security mechanism to verify the identity of the client and the server. (This must be requested by the client and cannot be required by Adaptive Server.)
- Message integrity – verify that data communications have not been modified.
- Replay detection – verify that data has not been intercepted by an intruder.
- Out-of-sequence check – verify the order of data communications.
- Message origin checks – verify the origin of the message.
- Remote procedure security – establish mutual authentication, message confidentiality, and message integrity for remote procedure communications.

➤ ***Note***

The security mechanism you are using may not support all of these services.

Auditing

Adaptive Server includes a comprehensive audit system. The audit system consists of a system database called *sybsecurity*, configuration parameters for managing auditing, a system procedure, **sp_audit**, to

set all auditing options, and a system procedure, **sp_addauditrecord**, to add user-defined records to the audit trail. When you install auditing, you can specify the number of audit tables that Adaptive Server will use for the audit trail. If you use two or more tables to store the audit trail, you can set up a smoothly running audit system with no manual intervention and no loss of records.

A System Security Officer manages the audit system and is the only user who can start and stop auditing, set up auditing options, and process the audit data. As a System Security Officer, you can establish auditing for events such as:

- Server-wide, security-relevant events
- Creating, deleting, and modifying database objects
- All actions by a particular user or all actions by users with a particular role active
- Granting or revoking database access
- Importing or exporting data
- Logins and logouts

Auditing functionality is discussed in Chapter 8, "Auditing."

User-Defined Login Security

UDLS gives you more control over security-related features of Adaptive Server.

In Adaptive Server 12.x, the System Security Officer can:

- Add more user logins and roles than was possible in earlier versions
- Specify the maximum allowable number of times an invalid password can be entered for a login or role before that login or role is automatically locked
- Lock and unlock roles manually
- Ensure that all user passwords have at least one digit
- Specify the minimum password length required server-wide or for a specific login or role
- Display all security-related information for logins and roles
- Associate a password expiration value with a specified login or role

Negative values may be used for user IDs (*uid*).

The server user ID (s*uid*) associated with a group or a role in *sysusers* is not equal to the negation of their user ID (*uid*). Every *suid* associated with a group or a role in *sysusers* is set to -2 (INVALID_SUID).

Setting and Changing the Maximum Login Attempts

Setting the maximum number of login attempts allowed provides protection against "brute-force" or dictionary-based attempts to guess passwords. A System Security Officer can specify a maximum number of consecutive login attempts allowed, after which the login or role is automatically locked. The number of allowable failed login attempts can be set for the entire server or for individual logins and roles. Individual settings override the server-wide setting.

The number of failed logins is stored in the *logincount* column in *master..syslogins*. A successful login resets the number of failed logins to 0.

Setting the Server-Wide Maximum Allowed Login Attempts

To set the server-wide maximum number of login attempts for logins and roles, use the **maximum failed logins** configuration parameter.

For example:

```
sp_configure "maximum failed logins", 5
```

Sets the system-wide maximum number of failed login attempts to 5.

For details on the syntax and rules for using **maximum failed logins**, see **sp_configure**.

Setting the Maximum Allowed Login Attempts for Specific Logins

To set the maximum number of login attempts for a specific login at creation, use **sp_addlogin**.

For example:

```
sp_addlogin joe, "Djdiek3", maxfailedlogins = 2
```

Creates the new login *joe* with the password "Djdiek3" and sets the maximum number of failed login attempts for the login *joe* to 2.

For details on the syntax and rules for using **maxfailedlogins**, see **sp_addlogin**.

Setting the Maximum Allowed Login Attempts for Specific Roles

To set the maximum number of login attempts for a specific role at creation, use **create role**.

For example:

```
create role intern_role with passwd "temp244",
max failed_logins 20
```

Creates the *intern_role* role with the password “temp244”, and sets the maximum number of failed login attempts for *intern_role* to 20.

For details on the syntax and rules for using **max failed_logins**, see **create role**.

Changing the Maximum Allowed Login Attempts for Specific Logins

Use **sp_modifylogin** to set or change the maximum failed login attempts for an existing login.

For example:

```
sp_modifylogin "joe", @option="max failed_logins",
@value="40"
```

Changes the maximum number of failed login attempts for the login “joe” to 40.

➤ ***Note***

The *value* parameter is a *character* datatype; therefore, quotes are required for numeric values.

```
sp_modifylogin "all overrides", "max
failed_logins", NULL, NULL, "3"
```

Changes the overrides for maximum failed login attempts of all logins to 3.

```
sp_modifylogin "all overrides", @option="max
failed_logins", @value="-1"
```

Removes the overrides for maximum failed logins option for all logins.

For details on the syntax and rules for using **max failed_logins**, see **sp_modifylogin**.

Changing the Maximum Allowed Login Attempts for Specific Roles

Use **alter role** to set or change the maximum failed login attempts for an existing role.

For example:

```
alter role physician_role set max failed_logins 5
```

Changes the maximum failed logins allowed for *physician_role* to 5.

```
alter role "all overrides" set max failed_logins -1
```

Removes the overrides for the maximum failed logins for all roles.

For details on the syntax and rules for using **max failed_logins**, see **alter role.**

Locking and Unlocking Logins and Roles

A login or role can be locked when:

- Its password expires, or
- The maximum number of failed login attempts occur, or
- The System Security Officer locks the login or role manually.

Locking and Unlocking Logins

The System Security Officer can use **sp_locklogin** to lock or unlock a login manually. (This is not new functionality, but is mentioned here for comparison to the new methods available for locking and unlocking roles.)

For example:

```
sp_locklogin "joe" , "lock"
sp_locklogin "joe" , "unlock"
```

Information about the lock status of a login is stored in the *status* column of *syslogins*.

For details on the syntax and rules for using **sp_locklogin**, see **sp_locklogin.**

Locking and Unlocking Roles

The System Security Officer can use **alter role** to lock or unlock a role manually.

For example:

```
alter role physician_role lock
alter role physician_role unlock
```

Information about the lock status of a role is stored in the *status* column of *syssrvroles*.

For details on the syntax and rules for using **lock** and **unlock**, see **alter role**.

Unlocking Logins and Roles at Server Startup

Automatic login lockouts can cause a site to end up in a situation in which all accounts capable of unlocking logins (System Administrators and System Security Officers) are locked. In these situations, use the **-u** flag with the **dataserver** utility to unlock a specific login or role when you start Adaptive Server.

For details on the syntax and rules for using the **-u** flag, see the *Utility Programs* manual for your platform.

Displaying Password Information

This section discusses displaying password information for logins and roles.

Displaying Password Information for Specific Logins

Use **sp_displaylogin** to display the password settings for a login.

For example, the following statement displays information about the login *joe*:

```
sp_displaylogin joe
```

```
Suid: 2
Loginame: joe
Fullname: Joseph Resu
Default Database: master
Default Language:
Configured Authorization: intern_role (default OFF)
Locked: NO
Date of Last Password Change: Nov 24 1997  3:35PM
Password expiration interval : 5
Password expired : NO
Minimum password length:4
Maximum failed logins : 10
Current failed logins : 3
```

For details on the syntax and rules, see **sp_displaylogin**.

Displaying Password Information for Specific Roles

Use **sp_displayroles** to display the password settings for a role.

For example:

```
sp_displayroles physician_role, "display_info"
```

```
Role name = physician_role
Locked : NO
Date of Last Password Change : Nov 24 1997  3:35PM
Password expiration interval = 5
Password expired : NO
Minimum password length = 4
Maximum failed logins = 10
Current failed logins = 3
```

Displays information about the *physician_role* role.

For details on the syntax and rules, see **sp_displayroles**.

Checking Passwords for At Least One Character

The System Security Officer can tell the server to check for at least one character or digit in a password using the server-wide configuration parameter, **check password for digit**. If set, this parameter does not affect existing passwords. By default, checking for digits is off.

For example:

```
sp_configure "check password for digit", 1
```

Activates the check password functionality.

```
sp_configure "check password for digit", 0
```

Deactivates the check password functionality.

For details on the syntax and rules for using the new parameter, see **sp_configure**.

Setting and Changing Minimum Password Length

In previous releases, the minimum password length was a non-configurable, hard-coded value of six characters. The configurable password allows you to customize passwords to fit your needs such as using four-digit personal identification numbers (PINs) or anonymous logins with NULL passwords.

The System Security Officer can specify:

- A globally enforced minimum password length
- A per-login or per-role minimum password length

The per-login or per-role value overrides the server-wide value. Setting a minimum password length affects only new passwords created after setting the value. It does not affect existing passwords.

Setting the Server-Wide Minimum Password Length

Use the **minimum password length** configuration parameter to specify a server-wide value for minimum password length for both logins and roles.

For example:

```
sp_configure "minimum password length", 4
```

Sets the minimum password length for all logins and roles to four characters.

For details on the syntax and rules for using **minimum password length**, see **sp_configure**.

Setting Minimum Password Length for a Specific Login

To set the minimum password length for a specific login at creation, use **sp_addlogin**.

For example:

```
sp_addlogin joe, "Djdiek3", @minpwdlen=4
```

Creates the new login *joe* with the password “Djdiek3”, and sets the minimum password length for *joe* to 4. d

For details on the syntax and rules for using **minpwdlen**, see **sp_addlogin**.

Setting Minimum Password Length for a Specific Role

To set the minimum password length for a specific role at creation, use **create role.**

For example:

```
create role intern_role with passwd "temp244",
min passwd length 0
```

Creates the new role *intern_role* with the password “temp244” and sets the minimum password length for *intern_role* to 0. The original password is seven characters, but the password can be changed to one of any length because the minimum password length is set to 0.

For details on the syntax and rules for using **min passwd length**, see **create role**.

Changing Minimum Password Length for a Specific Login

Use **sp_modifylogin** to set or change the minimum password length for an existing login.

For example:

```
sp_modifylogin "joe", @option="min passwd length",
@value="8"
```

Changes the minimum password length for the login “joe” to eight characters.

➤ ***Note***

The *value* parameter is a *character* datatype; therefore, quotes are required for numeric values.

```
sp_modifylogin "all overrides", "min passwd
length", @value="2"
```

Changes the value of the overrides for minimum password length of all logins to two characters.

```
sp_modifylogin "all overrides", @option="min
passwd length", @value="-1"
```

Removes the overrides for the minimum password length for all logins.

For details on the syntax and rules for using **min passwd length**, see **sp_modifylogin**.

Changing Minimum Password Length for a Specific Role

Use **alter role** to set or change the minimum password length for an existing role.

For example:

```
alter role physician_role set min passwd length 5
```

Sets the minimum length for *physician_role*, an existing role, to five characters.

```
alter role "all overrides" set min passwd length -1
```

Overrides the minimum password length of all roles.

For details on the syntax and rules for using **set min passwd length**, see **alter role**.

Setting the Expiration Interval for a Password

System Administrators and System Security Officers can:

Use	To
sp_addlogin	Specify the expiration interval for a login password at creation
sp_modifylogin	Change the expiration interval for a login password
create role	Specify the expiration interval for a role password at creation
alter role	Change the expiration interval for a role password

The following rules apply to password expiration for logins and roles:

- A password expiration interval assigned to individual login accounts or roles overrides the global password expiration value. This allows you to specify shorter expiration intervals for sensitive accounts or roles, such as System Security Officer passwords, and more relaxed intervals for less sensitive accounts such as an anonymous login.

- A login or role for which the password has expired is not directly activated.

For details on the syntax and rules for the commands and system procedures, see the *Adaptive Server Reference Manual.*

Password Expiration Turned Off for Pre-12.x Passwords

Password expiration did not affect roles in releases prior to Adaptive Server 12.x. Therefore, in Adaptive Server 12.x password expiration is deactivated for any existing user-defined role passwords. During the upgrade all user-defined role passwords are stamped as having a password interval of **0**.

Message for Impending Password Expiration

When a password for a login or role is about to expire, a warning message asks the user to contact the System Security Officer.

Circumventing Password Protection

Circumventing the password-protection mechanism may be necessary in the case of automated login systems. You can create a role that could access other roles without passwords.

If a System Security Officer wants to bypass the password mechanism for certain users, the System Security Officer can grant the password-protected role to another role and grant this new role to one or more users. Activation of this role automatically activates the password-protected role without having to provide a password.

For example:

Jane is the System Security Officer for the fictitious company ABC Inc., which uses automated login systems. Jane creates the following roles:

- *financial_assistant*

  ```
  create role financial_assistant with passwd
  "L54K3j"
  ```

- *accounts_officer*

  ```
  create role accounts_officer with passwd "9sF6ae"
  ```

- *chief_financial_officer*

  ```
  create role chief_financial_officer
  ```

Jane grants the roles of *financial_assistant* and *accounts_officer* to the *chief_financial_officer* role:

```
grant role financial_assistant, accounts_officer
to chief_financial_officer
```

Jane then grants the *chief_financial_officer* role to Bob:

```
grant role chief_financial_officer to bob
```

Bob logs in to Adaptive Server and activates the *chief_financial_officer* role:

```
set role chief_financial_officer on
```

The roles of *financial_assistant* and *accounts_officer* are automatically activated without Bob providing a password. Bob now has the ability to access everything under the *financial_assistant* and *accounts_officer* roles without having to enter the passwords for those roles.

Creating a Password Expiration Interval for a New Login

Use **sp_addlogin** to set the password expiration interval for a new login.

For example:

```
sp_addlogin joe, "Djdiek3", 2
```

Creates the new login *joe* with the password "Djdiek3", and sets the password expiration interval for *joe* to 2 days.

For details on the syntax and rules for using the new parameter, see **sp_addlogin**.

Creating a Password Expiration Interval for a New Role

Use **create role** to set the password expiration interval for a new role.

For example:

```
create role intern_role, with passwd "temp244",
passwd expiration 7
```

Creates the new role *intern_role* with the password "temp244", and sets the password expiration interval for *intern_role* to 7 days.

For details on the syntax and rules for using **passwd expiration**, see **create role**.

Creation Date Added for Passwords

Passwords are stamped with a "creation date" equal to the upgrade date of a given server. The creation date for login passwords is stored in the *pwdate* column of *syslogins*. The creation date for role passwords is stored in the *pwdate* column of *syssrvroles*.

Changing or Removing Password Expiration Interval for Login or Role

Use **sp_modifylogin** to change the password expiration interval for an existing login, add a password expiration interval to a login that did not have one, or remove a password expiration interval.

For example:

```
sp_modifylogin "joe", @option="passwd expiration",
@value="5"
```

Changes the password expiration interval for the login "joe" to 5 days.

➤ ***Note***

The *value* parameter is a *character* datatype; therefore, quotes are required for numeric values.

```
sp_modifylogin "all overrides",
@option="passwd expiration", @value="3"
```

Changes the value of the overrides for the password expiration for all logins to 3 days.

```
sp_modifylogin "all overrides”,
@option="passwd expiration", @value="-1"
```

Removes the value of the overrides for the password expiration for all logins.

For details on the syntax and rules for using **passwd expiration**, see **sp_modifylogin**.

6 Managing Adaptive Server Logins and Database Users

This chapter describes methods for managing Adaptive Server login accounts and database users. Topics include:

Adding New Users: An Overview

The process of adding new logins to Adaptive Server, adding users to databases, and granting them **permission** to use commands and database objects is divided among the System Security Officer, System Administrator, and Database Owner.

Adding new users consists of the following steps:

1. A System Security Officer uses **sp_addlogin** to create a server login account for a new user.
2. A System Administrator or Database Owner uses **sp_adduser** to add a user to a database. This command can also give the user an alias or assign the user to a group. For more information, see "Creating Groups" on page 6-5.
3. A System Security officer grants specific roles to the user.
4. A System Administrator, Database Owner, or object owner grants the user or group specific permissions on specific

commands and database objects. Users or groups can also be granted permission to grant specific permissions on objects to other users or groups. See Chapter 7, “Managing User Permissions” for detailed information about permissions.

Table 6-1 summarizes the system procedures and commands used for these tasks.

Table 6-1: Adding users to Adaptive Server and databases

Task	Required Role	Command or Procedure	Database
Create new logins, assign passwords, default databases, default language, and full name	System Security Officer	**sp_addlogin**	Any database
Create groups	Database Owner or System Administrator	**sp_addgroup**	User database
Create and assign roles	System Security Officer	**create role**	
Add users to database, assign aliases, and assign groups	Database Owner or System Administrator	**sp_adduser**	User database
Grant groups, users, or roles permission to create or access database objects	Database Owner, System Administrator, or object owner	**grant**	User database

Choosing and Creating a Password

Your password helps prevent access by unauthorized people. When you create your password, follow these guidelines:

- Do not use information such as your birthday, street address, or any other word or number that has anything to do with your personal life.
- Do not use names of pets or loved ones.
- Do not use words that appear in the dictionary or words spelled backwards.

The most difficult passwords to guess are those that combine uppercase and lowercase letters and numbers. Never give anyone your password, and never write it down where anyone can see it.

Follow these rules to create a password:

- Passwords must be at least 6 bytes long.

- Passwords can consist of any printable letters, numbers, or symbols.
- A password must be enclosed in quotation marks in **sp_addlogin** if it:
  - Includes any character other than A-Z, a-z, 0-9,_, #, valid single-byte or multibyte alphabetic characters, or accented alphabetic characters
  - Begins with a number 0–9

Adding Logins to Adaptive Server

Use **sp_addlogin** to add a new **login** name to Adaptive Server. You do not use it to give the user permission to access user databases. Use **sp_adduser** for that purpose. Only the System Security Officer can execute **sp_addlogin**. The syntax is:

```
sp_addlogin loginame, passwd [, defdb]
   [, deflanguage [, fullname]]]
```

where:

- *loginame* is the new user's login name. The login name must follow the rules for identifiers and must be unique on Adaptive Server. To simplify both the login process and server administration, make the Adaptive Server login name the same as the user's operating system login name. This makes logging in to Adaptive Server easier because many client programs use the operating system login name as a default. It also simplifies management of server and operating system login accounts, and makes it easier to correlate usage and audit data generated by Adaptive Server and by the operating system.
- *passwd* is the password for the new user. For guidelines on choosing and creating secure passwords, see "Choosing and Creating a Password" on page 6-2. For information on changing a password, see "Changing Passwords" on page 6-24.
- *defdb* is the **default database** – where the user starts each session of Adaptive Server.

➤ ***Note***

The default database is *master*. To discourage users from creating database objects in the *master* database, assign a default database other than *master* to most users.

A System Administrator can change anyone's default database with **sp_modifylogin**. Other users can change only their own default database.

After specifying the default database, add the user to the default database with **sp_adduser** so that he or she can log in directly to the default database.

- *deflanguage* is the **default language** in which the user's prompts and messages are displayed. If you omit this parameter, Adaptive Server's default language is used. A System Administrator can change any user's default language with **sp_modifylogin**. Other users can change only their own language.
- *fullname* is the full name of the user. This is useful for documentation and identification purposes. If omitted, no full name is added. A System Administrator can change any user's full name with **sp_modifylogin**. Other users can change only their own full name.

The following statement sets up an account for the user "maryd" with the password "100cents," the default database (*master*), the default language, and no full name:

```
sp_addlogin "maryd", "100cents"
```

The password requires quotation marks because it begins with 1.

After this statement is executed, "maryd" can log into Adaptive Server. She is automatically treated as a "guest" user in *master*, with limited permissions, unless she has been specifically given access to *master*.

The following statement sets up a login account ("omar_khayyam") and password ("rubaiyat") for user and makes *pubs2* the default database for this user:

```
sp_addlogin omar_khayyam, rubaiyat, pubs2
```

To specify a full name for a user and use the default database and language, you must specify **null** in place of the *defdb* and *deflanguage* parameters. For example:

```
sp_addlogin omar, rubaiyat, null, null,
    "Omar Khayyam"
```

Alternatively, you can specify a parameter name, in which case you do not have to specify all the parameters. For example:

```
sp_addlogin omar, rubaiyat,
    @fullname = "Omar Khayyam"
```

When you execute **sp_addlogin**, Adaptive Server adds a row to *master.dbo.syslogins*, assigns a unique server **user ID** (*suid*) for the new user, and fills in other information. When a user logs in, Adaptive Server looks in *syslogins* for the name and password provided by the user. The *password* column is encrypted with a one-way algorithm so it is not human-readable.

The *suid* column in *syslogins* uniquely identifies each user on Adaptive Server. A user's *suid* remains the same, no matter what database he or she is using. The *suid* 1 is always assigned to the default "sa" account that is created when Adaptive Server is installed. Other users' server user IDs are integers assigned consecutively by Adaptive Server each time **sp_addlogin** is executed.

Creating Groups

Groups provide a convenient way to grant and revoke permissions to more than one user in a single statement. Groups enable you to provide a collective name to a group of users. They are especially useful if you administer an Adaptive Server installation that has a large numbers of users. Every user is a member of the group "public" and can also be a member of one other group. (Users remain in "public," even when they belong to another group.)

It is probably most convenient to create groups before adding users to a database, since **sp_adduser** can assign users to groups as well as add them to the database.

A System Administrator or the Database Owner can create a group at any time with **sp_addgroup**. The syntax is:

```
sp_addgroup grpname
```

The group name, a required parameter, must follow the rules for identifiers. The System Administrator can assign or reassign users to groups with **sp_changegroup**.

To set up the Senior Engineering group, use the following command while using the database to which you want to add the group:

```
sp_addgroup senioreng
```

sp_addgroup adds a row to *sysusers* in the current database. Therefore, each group in a database, as well as each user, has an entry in *sysusers*.

Adding Users to Databases

The Database Owner or a System Administrator can use **sp_adduser** to add a user to a specific database. The user must already have an Adaptive Server login. The syntax is:

sp_adduser *loginame* [, *name_in_db* [, *grpname*]]

where:

- *loginame* is the login name of an existing user.
- *name_in_db* specifies a name that is different from the login name by which the user is to be known inside the database.

  You can use this feature to accommodate users' preferences. For example, if there are five Adaptive Server users named Mary, each must have a different login name. Mary Doe might log in as "maryd", Mary Jones as "maryj", and so on. However, if these users do not use the same databases, each might prefer to be known simply as "mary" inside a particular database.

  If no *name_in_db* parameter is given, the name inside the database is the same as *loginame*.

➤ ***Note***

This capability is different from the alias mechanism described in "Using Aliases in Databases" on page 6-28, which maps the identity and permissions of one user to another.

- *grpname* is the name of an existing group in the database. If you do not specify a group name, the user is made a member of the default group "public." Users remain in "public" even if they are a member of another group. See "Changing a User's Group Membership" on page 6-26 for information about modifying a user's group membership.

sp_adduser adds a row to the *sysusers* system table in the current database. When a user has an entry in the *sysusers* table of a database, he or she:

- Can issue **use *database_name*** to access that database
- Will use that database by default, if the default database parameter was issued as part of **sp_addlogin**
- Can use **sp_modifylogin** to make that database the default

This example shows how a Database Owner could give access permission to "maryh" of the engineering group "eng," which already exists:

```
sp_adduser maryh, mary, eng
```

This example shows how to give "maryd" access to a database, keeping her name in the database the same as her login name:

```
sp_adduser maryd
```

This example shows how to add "maryj" to the existing "eng" group, keeping her name in the database the same as her login name by using **null** in place of a new user name:

```
sp_adduser maryj, null, eng
```

Users who have access to a database still need permissions to read data, modify data, and use certain commands. These permissions are granted with the **grant** and **revoke** commands, discussed in Chapter 7, "Managing User Permissions."

Adding a "guest" User to a Database

Creating a user named "guest" in a database enables any user with an Adaptive Server account to access the database as a **guest** user. If a user issues the **use** *database_name* command, and his or her name is not found in the database's *sysusers* or *sysalternates* table, Adaptive Server looks for a guest user. If there is one, the user is allowed to access the database, with the permissions of the guest user.

The Database Owner can add a guest entry to the *sysusers* table of the database with **sp_adduser**:

```
sp_adduser guest
```

The guest user can be removed with **sp_dropuser**, as discussed in "Dropping Users" on page 6-20.

If you drop the guest user from the *master* database, server users who have not yet been added to any databases will be unable to log in to Adaptive Server.

➤ ***Note***

Although more than one individual can be a guest user in a database, you can still use the user's server user ID, which is unique within the server, to audit each user's activity. For more information about auditing, see Chapter 8, "Auditing."

"guest" User Permissions

"Guest" inherits the privileges of "public." The Database Owner and the owners of database objects can use **grant** and **revoke** to make the privileges of "guest" either more or less restrictive than those of "public." See Chapter 7, "Managing User Permissions," for a description of the "public" privileges.

When you install Adaptive Server, *master..sysusers* contains a guest entry. The installation script for the *pubs2* database also contains a guest entry for its *sysusers* table.

"guest" User in User Databases

In user databases, the Database Owner adds a guest user that permits all Adaptive Server users to use that database. This saves the owner from having to use **sp_adduser** to explicitly name each one as a database user.

You can use the guest mechanism to restrict access to database objects while allowing access to the database.

For example, the owner of the *titles* table could grant **select** permission on *titles* to all database users except "guest" by executing these commands:

```
grant select on titles to public
sp_adduser guest
revoke all on titles from guest
```

"guest" User in *pubs2* and *pubs3*

The "guest" user entry in the sample databases allows new Adaptive Server users to follow the examples in the *Transact-SQL User's Guide*. The guest is given a wide range of privileges, including:

- **select** permission and data modification permission on all of the user tables
- **execute** permission on all of the procedures
- **create table, create view, create rule, create default,** and **create procedure** permissions

Creating Visitor Accounts

The System Security Officer can use **sp_addlogin** to enter a login name and password that visiting users are instructed to use. Typically, such users are granted restricted permissions. A default database may be assigned.

◆ ***WARNING!***

A visitor user account is not the same as the "guest" user account. All users of the visitor account have the same server user ID; therefore, you cannot audit individual activity. Setting up a visitor account to be used by more than one user is not recommended.

Adding Remote Users

You can allow users on another Adaptive Server to execute stored procedures on your server by enabling remote access. Working with the System Administrator of the remote server, you can also allow users of your server to execute **remote procedure calls** to the remote server.

To enable remote procedure calls, both the local and the remote server must be configured. For information about setting up remote servers and adding remote users, see Chapter 9, "Managing Remote Servers."

➤ ***Note***

Remote users and remote procedure calls are not included in the evaluated configuration.

Number of User and Login IDs

Adaptive Server supports over 2 billion logins per server and users per database. To use these large values, the datatype of *uid*, *gid*, and *suid* in all columns in system tables that store these values has been changed from *smallint* to *int*. Adaptive Server uses negative numbers as well as positive numbers to increase the range of possible numbers available for IDs.

Limits and Ranges of ID Numbers

Figure 6-1 illustrates the limits and ranges for logins, users, and groups.

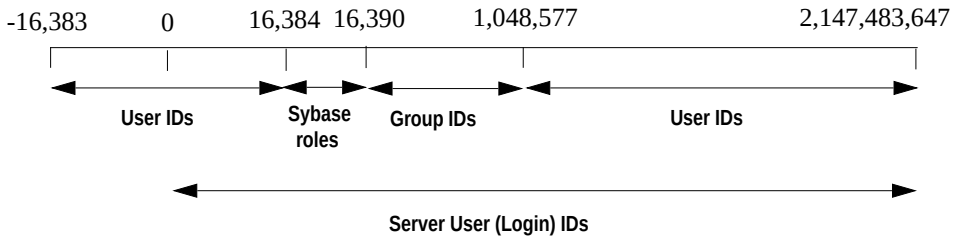

Figure 6-1: Users, groups, and logins available in Adaptive Server

Login Connection Limitations

Although Adaptive Server allows you to define over two billion logins per server, the actual number of users that can connect to Adaptive Server at one time is limited by:

- The value of the **number of user connections** configuration parameter, and
- The number of file descriptors available for Adaptive Server.

  Each login uses one file descriptor for the connection.

➤ ***Note***

The datatype of the server process ID (*spid*) has not been changed. Therefore, the maximum number of concurrent tasks running on the server is still thirty-two thousand.

To allow the maximum number of logins and simultaneous connections:

1. Configure the operating system on which Adaptive Server is running for at least thirty-two thousand file descriptors.
2. Set the value of **number of user connections** to at least thirty-two thousand.

Creating and Assigning Roles to Users

The final steps in adding database users are assigning them special roles, as required, and granting permissions. For more information on permissions, see Chapter 7, "Managing User Permissions."

The roles supported by Adaptive Server enable you to enforce individual accountability. Adaptive Server provides **system roles**, such as System Administrator and System Security Officer, and **user-defined roles**, which are created by a System Security Officer. Object owners can grant database access as appropriate to each role.

Table 6-2 lists the system roles, the value to use for the *role_granted* option of the **grant role** or **revoke role** command, and the tasks usually performed by a person with that role.

Table 6-2: System roles and related tasks

Role	Value for *role_granted*	Description
System Administrator	**sa_role**	Manages and maintains Adaptive Server databases and disk storage
System Security Officer	**sso_role**	Performs security-related tasks
Operator	**oper_role**	Backs up and loads databases server-wide

➤ ***Note***

The **sybase_ts_role**, **replication_role**, and **navigation_role** roles are not included in the evaluated configuration.

Planning User-Defined Roles

Before you implement user-defined roles, decide:

- The roles you want to create
- The responsibilities for each role
- The position of each in the role hierarchy
- Which roles in the hierarchy will be mutually exclusive
- Whether such exclusivity will be at the membership level or activation level

User-defined role names cannot duplicate user names.

Avoid name-conflicts when you create user-defined roles by following a naming convention. For example, you could use the "_role" suffix for role names. Adaptive Server does not check for such restrictions.

If a role must have the same name as a user, you can avoid conflict by creating a new role, having it contain the original role, and then granting the new role to the user.

If role names are identical to user names, Adaptive Server grants the role to the user.

Role Hierarchies and Mutual Exclusivity

A System Security Officer can define role hierarchies such that if a user has one role, the user also has roles lower in the hierarchy. For example, the "chief_financial_officer" role might contain both the "financial_analyst" and the "salary_administrator" roles, as shown in Figure 6-2.

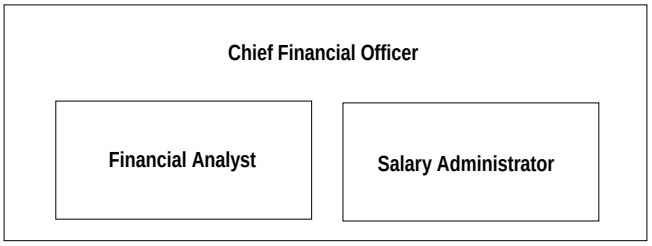

Figure 6-2: Role hierarchy

The Chief Financial Officer can perform all tasks and see all data that can be viewed by the salary administrators and financial analysts.

Roles can be defined to be mutually exclusive for:

- Membership – One user cannot be granted two different roles. For example, you might not want the "payment_requestor" and "payment_approver" roles to be granted to the same user.
- Activation – One user cannot activate, or enable, two different roles. For example, a user might be granted both the "senior_auditor" and the "equipment_buyer" roles, but not permitted to have both roles enabled at the same time.

System roles, as well as user-defined roles, can be defined to be in a role hierarchy or to be mutually exclusive. For example, you might

want a “super_user” role to contain the System Administrator, Operator, and “tech_support” roles. You might also want to define the System Administrator and System Security Officer roles to be mutually exclusive for membership; that is, one user cannot be granted both roles.

Configuring User-Defined Roles

After you have planned the roles to create and the relationships among them, configure your system for user-defined roles with the **max roles enabled per user** configuration parameter.

The maximum number of roles that a user can activate per user session is 127. The default value is 20. The minimum number of roles, which is 10, includes the system roles that come with Adaptive Server.

The maximum number of roles that can be activated server-wide is 992. The first 32 roles are reserved for Sybase system roles.

Creating a User-Defined Role

Use the **create role** command to create a role. The syntax is:

```
create role role_name [with passwd "password"]
```

where:

- *role_name* is the name of a new role.
- *password* is an optional password that must be specified by the user who will use the role.

For example, to create the **intern_role** without a password, enter:

```
create role intern_role
```

To create the **doctor_role** and assign the password “physician”, enter:

```
create role doctor_role with passwd "physician"
```

Adding and Removing Passwords from a Role

Only a System Security Officer can add or drop a password from a role.

Use the **alter role** command to add or drop a password from either a system or user-defined role. The syntax is:

```
alter role role_name [add passwd password |
   drop passwd]
```

For example, to require the password "oper8x" for the **oper_role**, enter:

```
alter role oper_role add passwd oper8x
```

To drop the password from the role, enter:

```
alter role oper_role drop passwd
```

Defining and Changing Mutual Exclusivity of Roles

To define mutual exclusivity between two roles, use:

```
alter role role1 { add | drop } exclusive {
   membership | activation } role2
```

For example, to define **intern_role** and **specialist_role** as mutually exclusive at the membership level, enter:

```
alter role intern_role add exclusive membership specialist_role
```

To define **sso_role** and **sa_role** as mutually exclusive at the activation level, enter:

```
alter role sso_role add exclusive activation sa_role
```

Defining and Changing a Role Hierarchy

Defining a role hierarchy involves choosing the type of hierarchy and the roles, then implementing the hierarchy by granting roles to other roles.

For example:

```
grant role intern_role to specialist_role
grant role doctor_role to specialist_role
```

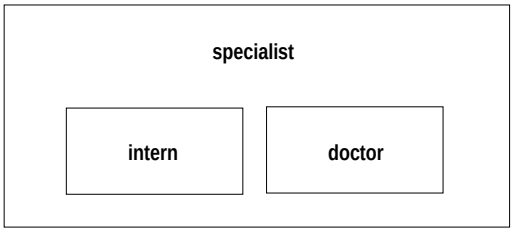

Figure 6-3: Creating a role hierarchy

In Figure 6-3, the "specialist" role contains the "doctor" and "intern" roles. This means that "specialist" has all the privileges of both "doctor" and "intern."

To establish a hierarchy with a "super_user" role containing the **sa_role** and **oper_role** system roles, specify:

```
grant role sa_role to super_user
grant role oper_role to super_user
```

When creating role hierarchies:

- You cannot grant a role to another role that directly contains it. This prevents duplication.

  For example, in Figure 6-3, you cannot grant the "doctor" role to the "specialist" role because "specialist" already contains "doctor."

- You can grant a role to another role that does not directly contain it.

  For example, in Figure 6-4, you can grant the "intern" role to the "specialist" role, even though "specialist" already contains the "doctor" role, which contains "intern."

  If you subsequently drop "doctor" from "specialist," then "specialist" still contains "intern."

  In Figure 6-4, "doctor" has "consultant" role permissions because "consultant" has been granted "doctor." The "specialist" role also has "consultant" role permissions because "specialist" contains the "doctor" role, which in turn contains the "consultant."

However, “intern” does not have “consultant” role privileges, because “intern” does not contain the “consultant” role, either directly or indirectly.

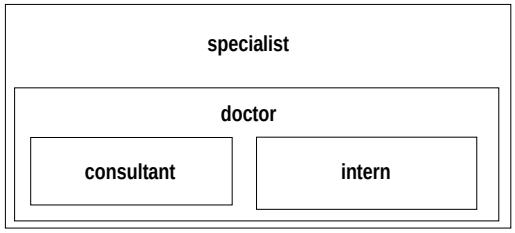

Figure 6-4: Explicitly and implicitly granted privileges

- You cannot grant a role to another role that is contained by the first role. This prevents “loops” within the hierarchy.

  For example, in Figure 6-5, you cannot grant the “specialist” role to the “consultant” role; “consultant” is already contained in “specialist”.

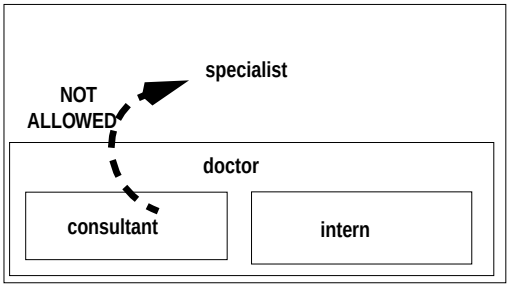

Figure 6-5: Granting a role to a role contained by grantor

- When the System Security Officer grants a user a role that contains other roles, the user implicitly gets membership in all roles contained by the granted role. However, a role can only be activated or deactivated directly if the user has explicit membership in that role.

- The System Security Officer cannot grant one role to another role that is explicitly or implicitly mutually exclusive at the membership level with the first role.

  For example, in Figure 6-6, if the “intern” role is defined as mutually exclusive at the membership level with the “consultant” role, the System Security Officer cannot grant “intern” to the “doctor.”

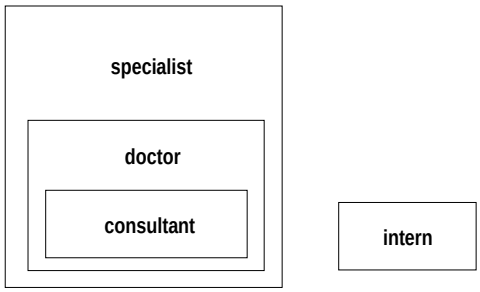

Figure 6-6: Mutual exclusivity at membership

- The user can activate or deactivate only directly granted roles.

  For example, in the hierarchy shown in Figure 6-6, assume that you have been granted the “specialist” role. You have all the permissions of the “specialist” role, and, implicitly, because of the hierarchy, you have all the permissions of the “doctor” and “consultant” roles. However, you can activate only the “specialist” role. You cannot activate “doctor” or “consultant” because they were not directly granted to you. For information, see “Activating and Deactivating Roles” on page 6-19.

  Revoking roles from other roles is similar to granting roles to other roles. It removes a containment relationship, and the

containment relationship must be a direct one, as shown in Figure 6-7:

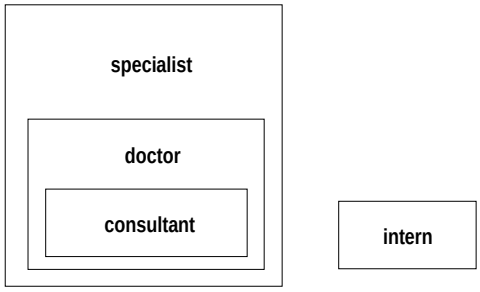

Figure 6-7: Effect of revoking roles on role hierarchy

For example, in Figure 6-7:

- If the System Security Officer revokes the "doctor" role from "specialist," "specialist" no longer contains the "consultant" role or the "intern" role.
- The System Security Officer cannot revoke the "intern" role from "specialist" because "intern" is not directly contained by "specialist."

Setting Up Default Activation at Login

A System Security Officer can change a role's default setting for any user. Individual users can change only their own default settings.

When a user logs in to Adaptive Server, the user's roles are not necessarily active, depending upon the default that is set for the role. If a role has a password associated with it, the user must use the **set role** command to activate the role.

The System Security Officer or user determines whether to activate any roles granted by default at login. **sp_modifylogin** sets the default status of user roles individually for each user.

By default, user-defined roles are not activated at login, but system roles are automatically activated, if they do not have passwords associated with them.

To set up a role to activate at login:

```
sp_modifylogin loginname, "add default role",
   role_name
```

To ensure that a role is inactive at login:

```
sp_modifylogin loginname, "drop default role",
   role_name
```

For example, to change the default setting for Ralph's **intern_role** to be active automatically at login, execute:

```
sp_modifylogin ralph, "add default role", intern_role
```

Activating and Deactivating Roles

Roles must be active to have the access privileges of each role. Depending on the default set for a role, the role may or may not be active at login. If the role has a password, it will always be inactive at login.

To activate or deactivate a role:

```
set role role_name [on|off]
```

To activate or deactivate a role that has an attached password, use:

```
set role role_name with passwd "password" [on|off]
```

For example, to activate the "financial_analyst" role with the password "sailing19", enter:

```
set role financial_analyst with passwd "sailing19"
```

You should activate roles only when you need them and turn them off when you no longer need them. For example, when the **sa_role** is active, you assume the identity of Database Owner within any database that you use. To turn off the System Administrator role and assume your "real" user identity, use:

```
set role sa_role off
```

If you are granted a role during a session, and you want to activate it immediately, use **set role** to turn it on.

Dropping Users, Groups and User-Defined Roles

Table 6-3 list the system procedures that allow a System Administrator or Database Owner to drop users and groups.

Table 6-3: Dropping users and groups

Task	Required Role	System Procedure	Database
Drop user from database	Database Owner or System Administrator	**sp_dropuser**	User database
Drop group from database	Database Owner or System Administrator	**sp_dropgroup**	User database

Dropping Users

A Database Owner or a System Administrator can use **sp_dropuser** to deny an Adaptive Server user access to the database in which **sp_dropuser** is executed. (If a "guest" user is defined in that database, the user can still access that database as "guest.")

The syntax is:

```
sp_dropuser name_in_db
```

where *name_in_db* is usually the login name, unless another name has been assigned.

You cannot drop a user who owns objects. Since there is no command to transfer ownership of objects, you must drop objects owned by a user before you drop the user with **sp_dropuser**. To deny access to a user who owns objects, use **sp_locklogin** to lock his or her account.

You also cannot drop a user who has granted permissions to other users. Use **revoke with cascade** to revoke permissions from all users who were granted permissions by the user to be dropped, then drop the user. You must then grant permissions to the users again, if appropriate.

Dropping Groups

Use **sp_dropgroup** to drop a group. The syntax is:

```
sp_dropgroup grpname
```

You cannot drop a group that has members. If you try to do so, the error report displays a list of the members of the group you are

attempting to drop. To remove users from a group, use **sp_changegroup**, discussed in "Changing a User's Group Membership" on page 6-26.

Dropping User-defined Roles

To drop a role, use:

```
drop role role_name [with override]
```

where *role_name* is the name of a user-defined role. **with override** revokes all access privileges granted to the role in every database server-wide.

If the role has any access privileges already granted, you must revoke all privileges granted to the role in all databases before you can drop the role. If you do not, the command fails. To revoke privileges:

- Use the **revoke** command, or
- Use the **with override** option with the **drop role** command. The **with override** option ensures that Adaptive Server automatically removes permission information for the role from all databases.

You need not drop memberships before dropping a role. Dropping a role automatically removes any user's membership in that role, regardless of whether you use the **with override** option.

Locking or Dropping Adaptive Server Login Accounts

To prevent a user from logging in to Adaptive Server, you can either lock or drop an Adaptive Server login account. Locking a login is safer than dropping it because locking a login account maintains the *suid* so that it cannot be reused.

◆ ***WARNING!***

Adaptive Server may reuse the server user ID (*suid*) of a dropped login account when the next login account is created. This occurs only when the dropped login holds the highest *suid* in *syslogins*; however, it can compromise accountability if execution of sp_droplogin is not being audited. Also, it is possible for a user with the reused *suid* to access database objects that were authorized for the old *suid*.

You cannot drop a login when:

- The user is in any database
- The login belongs to the last remaining System Security Officer or System Administrator

Table 6-4: Locking or dropping login accounts

Task	Required Role	System Procedure	Database
Lock login account, which maintains the *suid* so that it cannot be reused	System Administrator or System Security Officer	**sp_locklogin**	*master*
Drop login account, which allows reuse of *suid*	System Administrator	**sp_droplogin**	*master*

Locking and Unlocking Login Accounts

Use **sp_locklogin** to lock and unlock accounts or to display a list of locked accounts. You must be a System Administrator or a System Security Officer to use **sp_locklogin**.

The syntax is:

```
sp_locklogin [loginame, "{lock | unlock}"]
```

where:

- *loginame* is the name of the account to be locked or unlocked. It must be an existing valid account.
- **lock** | **unlock** specifies whether the account is to be locked or unlocked.

To display a list of all locked logins, use **sp_locklogin** with no parameters.

You can lock an account that is currently logged in, and the user is not locked out of the account until he or she logs out. You can lock the account of a Database Owner, and a locked account can own objects in databases. In addition, you can use **sp_changedbowner** to specify a locked account as the owner of a database.

Adaptive Server ensures that there is always at least one unlocked System Security Officer's account and one unlocked System Administrator's account.

Dropping Login Accounts

A System Administrator can use **sp_droplogin** to deny a user access to Adaptive Server. The syntax is:

```
sp_droplogin loginame
```

You cannot use sp_droplogin to drop a user from any database on the server. Use **sp_dropuser** to drop the user from a database. You cannot drop a user from a database if that user owns any objects in the database. For more information, see "Dropping Users" on page 6-20.

Locking Logins That Own Thresholds

This section discusses thresholds and how they are affected by locked user logins.

- As a security measure, threshold stored procedures are executed using the account name and roles of the login that created the procedure.
  - You cannot drop the login of a user who owns a threshold.
  - If you lock the login of a user who owns a threshold, the threshold cannot execute the stored procedure.
- Threshold procedures are executed with the most limited set of the roles assigned to the user. The user must have both of the following:
  - The set of roles active for the user at the time the threshold was added or last modified, and
  - The set of roles directly granted to the user at the time the threshold "fires."
- If a threshold requires a particular role, that role must be active for the user when the threshold is created. If that role is later revoked, the threshold cannot execute the procedure.
- The last chance threshold and thresholds created by the "sa" login are not affected by **sp_locklogin**. If you lock the "sa" login, the last chance threshold and thresholds created or modified by the "sa" user still fire.

Changing User Information

Table 6-5 lists the system procedures you use to change passwords, default database, default language, full name, or group assignment.

Table 6-5: System procedures for changing user information

Task	Required Role	System Procedure	Database
Change your password	None	**sp_password**	Any database
Change another user's password	System Security Officer	**sp_password**	Any database
Change your default database, default language, or full name	None	**sp_modifylogin**	Any database
Change a login account's default database, default language, or full name	System Administrator	**sp_modifylogin**	Any database
Change the group assignment of a user	System Administrator, Database Owner	**sp_changegroup**	User database

Changing Passwords

All users can change their passwords at any time using **sp_password**. The System Security Officer can use **sp_password** to change any user's password. The syntax is:

```
sp_password caller_passwd, new_passwd [, loginame]
```

where:

- *caller_passwd* is the password of the login account that is currently executing **sp_password**.
- *new_passwd* is the new password for the user executing **sp_password**, or for the user indicated by *loginame*. For guidelines on choosing and creating secure passwords, see "Choosing and Creating a Password" on page 6-2.
- *loginame* can be used only by a System Security Officer to change another user's password.

For example, a user can change his or her own password from "3blindmice" to "2mediumhot" using:

```
sp_password "3blindmice", "2mediumhot"
```

These passwords are enclosed in quotes because they begin with numbers.

In the following example, the System Security Officer whose password is "2tomato" changes Victoria's password to "sesame1":

```
sp_password "2tomato", sesame1, victoria
```

Requiring New Passwords

Your site may choose to use the **systemwide password expiration** configuration parameter to establish a password expiration interval, which forces all Adaptive Server users to change their passwords on a regular basis. For information, see Chapter 17, "Setting Configuration Parameters." Even if you do not use **systemwide password expiration**, it is important, for security reasons, that users change their passwords periodically.

The column *pwdate* in the *syslogins* table records the date of the last password change. The following query selects all login names whose passwords have not changed since September 15, 1997:

```
select name, pwdate
from syslogins
where pwdate < "Sep 15 1997"
```

Null Passwords

Do not assign a null password. When Adaptive Server is installed, the default "sa" account has a null password. The following example shows how to change a null password to a valid one:

```
sp_password null, "8M4LNCH"
```

Note that "null" is not enclosed in quotes in the statement.

Changing User Defaults

Any user can use **sp_modifylogin** to change his or her default database, default language, or full name. A System Administrator can change these settings for any user. The syntax is:

sp_modifylogin ***account*, *column*, *value***

- *account* is the name of the user whose account you are modifying.
- *column* specifies the option that you are changing. The options are:

  - **defdb** – The "home" database to which the user is connected when he or she logs in
  - **deflanguage** – The official name of the user's default language, as stored in *master..syslanguages*
  - **fullname** – The user's full name
- *value* is the new value for the specified option.

After you execute **sp_modifylogin** to change the default database, the user is connected to the new default database the next time he or she logs in. However, **sp_modifylogin** does not automatically give the user access to the database. Unless the Database Owner has set up access with **sp_adduser**, **sp_addalias**, or with a guest user mechanism, the user is connected to *master* even after his or her default database has been changed.

This example changes the default database for "anna" to *pubs2*:

```
sp_modifylogin anna, defdb, pubs2
```

This example changes the default language for "claire" to French:

```
sp_modifylogin claire, deflanguage, french
```

This example changes the full name for "mtwain" to "Samuel Clemens."

```
sp_modifylogin mtwain, fullname, "Samuel Clemens"
```

Changing a User's Group Membership

A System Administrator or the Database Owner can use **sp_changegroup** to change a user's group affiliation. Each user can be a member of only one group other than "public," of which all users are always members.

Before you execute **sp_changegroup**:

- The group must exist. (Use **sp_addgroup** to create a group.)
- The user must have access to the current database (must be listed in *sysusers*).

The syntax for **sp_changegroup** is:

```
sp_changegroup grpname, username
```

For example, to change the user "jim" from his current group to the group "manage," use:

```
sp_changegroup manage, jim
```

To remove a user from a group without assigning the user to another group, you must change the group affiliation to "public":

```
sp_changegroup "public", jim
```

The name "public" must be in quotes because it is a reserved word. This command reduces Jim's group affiliation to "public" only.

When a user changes from one group to another, the user loses all permissions that he or she had as a result of belonging to the old group, but gains the permissions that have been granted to the new group.

The assignment of users into groups can be changed at any time.

Changing the User Process Information

The **set** command includes options that allow you to assign each client an individual name, host name, and application name. This is useful for differentiating among clients in a system where many clients connect to Adaptive Server using the same name, host name, or application name.

The partial syntax for the **set** command is:

```
set [clientname client_name | clienthostname
   host_name | clientapplname application_name]
```

Where *client_name* is the name you are assigning the client, *host_name* is the name of the host from which the client is connecting, and *application_name* is the application that is connecting to Adaptive Server. These parameters are stored in the *clientname*, *clienthostname*, *clientapplname* columns of the *sysprocesses* table.

For example, if a user logs in to Adaptive Server as "client1," you can assign them an individual client name, host name, and application name using commands similar to:

```
set clientname 'alison'
set clienthostname 'money1'
set clientapplname 'webserver2'
```

This user now appears in the *sysprocesses* table as user "alison" logging in from host "money1" and using the "webserver2" application. However, although the new names appear in *sysprocesses*, they are not used for permission checks, and **sp_who** still shows the client connection as belonging to the original login (in the case above, client1). **set clientname** does not perform the same function as **set proxy**, which allows you to assume the permissions, login name, and suid of another user.

You can set a client name, host name, or application name for only your current client session (although you can view the connection information for any client connection). Also, this information is lost when a user logs out. These parameters must be reassigned each time a user logs in. For example, the user alison cannot set the client name, host name, or application name for any other client connection.

Use the client's spid to view their connection information. For example, if the client "alison" described above connects with a spid of 13, issue the following command to view all the connection information for this client:

```
select * from sysprocesses where spid = 13
```

To view the connection information for the current client connection (for example, if the user alison wanted to view her own connection information), enter:

```
select * from sysprocesses where spid = @@spid
```

Using Aliases in Databases

The alias mechanism allows you to treat two or more users as the same user inside a database so that they all have the same privileges. This mechanism is often used so that more than one user can assume the role of Database Owner. A Database Owner can use the **setuser** command to impersonate another user in the database. You can also use the alias mechanism to set up a collective user identity.

For example, suppose that several vice presidents want to use a database with identical privileges and ownerships. If you add the login "vp" to Adaptive Server and the database and have each vice president log in as "vp," there is no way to tell the individual users apart. Instead, alias all the vice presidents, each of whom has his or her own Adaptive Server account, to the database user name "vp."

➤ ***Note***

Although more than one individual can use the alias in a database, you can still maintain individual accountability by auditing the database operations performed by each user. For more information about auditing, see Chapter 8, "Auditing."

Table 6-6 lists the system procedures used to manage aliases:

Table 6-6: System procedures for managing aliases

Task	Require Role	System Procedure	Database
Add an alias for a user	Database Owner or System Administrator	**sp_addalias**	User database
Drop an alias	Database Owner or System Administrator	**sp_dropalias**	User database

Adding Aliases

To add an alias for a user, use **sp_addalias**. The syntax is:

```
sp_addalias loginame, name_in_db
```

where:

loginame is the name of the user who wants an alias in the current database. This user must have an account in Adaptive Server but cannot be a user in the current database.

name_in_db is the name of the database user to whom the user specified by *loginame* is to be linked. The *name_in_db* must exist in both *master..syslogins* and in *sysusers* in the current database.

Executing **sp_addalias** maps the user name specified by *loginame* to the user name specified by *name_in_db*. It does this by adding a row to the system table *sysalternates*.

When a user tries to use a database, Adaptive Server checks for the user's server user ID number (*suid*) in *sysusers*. If it is not found, Adaptive Server then checks *sysalternates*. If the user's *suid* is found there, and it is mapped to a database user's *suid*, the first user is treated as the second user while the first user is using the database.

For example, suppose that Mary owns a database. She wants to allow both Jane and Sarah to use the database as if they were its owner. Jane and Sarah have logins on Adaptive Server but are not authorized to use Mary's database. Mary executes the following commands:

```
sp_addalias jane, dbo
exec sp_addalias sarah, dbo
```

◆ ***WARNING!***

Users who are aliased to the Database Owner have all the permissions and can perform all the actions that can be performed by the real Database Owner, with respect to the database in question. A Database Owner should carefully consider the implications of vesting another user with full access to a database.

Dropping Aliases

Use **sp_dropalias** to drop the mapping of an alternate *suid* to a user ID. Doing this deletes the relevant row from *sysalternates*. The syntax is:

```
sp_dropalias loginame
```

where *loginame* is the name of the user specified by *loginame* when the name was mapped with **sp_addalias**. After a user's alias is dropped, the user no longer has access to the database.

Getting Information About Aliases

To display information about aliases, use **sp_helpuser**. For example, to find the aliases for "dbo," execute:

```
sp_helpuser dbo
Users_name     ID_in_db    Group_name   Login_name
----------     --------    ----------   ----------
dbo            1           public       sa

(1 row affected)
             Users aliased to user.
             Login_name
             ----------------------
             andy
             christa
             howard
             linda

             (4 rows affected)
```

Getting Information About Users

Table 6-7 lists procedures you can use to obtain information about users, groups, and current Adaptive Server usage.

Table 6-7: Reporting information about Adaptive Server users and groups

Task	Procedure
Report current Adaptive Server users and processes	**sp_who**
Display information about login accounts	**sp_displaylogin**
Report users and aliases in a database	**sp_helpuser**
Report groups within a database	**sp_helpgroup**

Getting Reports on Users and Processes

Use **sp_who** to report information about current users and processes on Adaptive Server:

```
sp_who [loginame | "spid"]
```

where:

- *loginame* is the user's Adaptive Server login name. If you give a login name, **sp_who** reports information about processes being run by that user.
- *spid* is the number of a specific process.

For each process being run, **sp_who** reports the server process ID, its status, the login name of the process user, the name of the host computer, the server process ID of a process that's blocking this one (if any), the name of the database, and the command being run.

If you do not give a login name or *spid*, **sp_who** reports on processes being run by all users.

The following example shows the results of executing **sp_who** without a parameter:

```
spid   status   loginame hostname blk dbname cmd
------ -------- -------- -------- --- ------ ----------------
     1 running  sa       sunbird  0   pubs2  SELECT
     2 sleeping NULL              0   master NETWORK HANDLER
     3 sleeping NULL              0   master MIRROR HANDLER
     4 sleeping NULL              0   master AUDIT PROCESS
     5 sleeping NULL              0   master CHECKPOINT SLEEP

(5 rows affected, return status = 0)
```

sp_who reports NULL for the *loginame* for all system processes

Getting Information About Login Accounts

Use **sp_displaylogin** to display information about a specified login account, including any roles granted to that account:

sp_displaylogin [*loginame*]

where *loginame* is the user login account about which you want information. If you are not a System Security Officer or System Administrator, you can get information only about your own account. If you are a System Security Officer or System Administrator, you can use the *loginame* parameter to access information about any account.

sp_displaylogin displays your server user ID, login name, full name, any roles that have been granted to you, date of last password change, default database, default language, and whether your account is locked.

sp_displaylogin displays all roles that have been granted to you, so even if you have made a role inactive with the **set** command, that role is displayed.

Getting Information About Database Users

Use **sp_helpuser** to report information about authorized users of the current database:

sp_helpuser [*name_in_db*]

where *name_in_db* is the user's name in the current database. If you give a user's name, **sp_helpuser** reports information about that user. If you do not give a name, it reports information about all users.

The following example shows the results of executing **sp_helpuser** without a parameter in the database *pubs2*:

```
                sp_helpuser
Users_name  ID_in_db  Group_name Login_name
----------  --------  ---------- ----------
dbo         1         public     sa
marcy       4         public     marcy
sandy       3         public     sandy
judy        5         public     judy
linda       6         public     linda
anne        2         public     anne
jim         7         senioreng  jim

(7 rows affected)
```

Finding User Names and IDs

To find a user's server user ID or login name, use **suser_id** and **suser_name.**

Table 6-8: System functions suser_id and suser_name

To Find	Use	With the Argument
Server user ID	**suser_id**	**(["server_user_name"])**
Server user name (login name)	**suser_name**	**([server_user_ID])**

The arguments for these system functions are optional. If you do not provide one, Adaptive Server displays information about the current user.

This example shows how to find the server user ID for the user "sandy:"

```
select suser_id("sandy")

------
     3
```

This example shows how a System Administrator whose login name is "mary" issues the commands without arguments:

```
select suser_name(), suser_id()

------------------------------ ------
mary                                4
```

To find a user's ID number or name inside a database, use **user_id** and **user_name.**

Table 6-9: System functions user_id and user_name

To Find	Use	With the Argument
User ID	**user_id**	**(["db_user_name"])**
User name	**user_name**	**([db_user_ID])**

The arguments for these functions are optional. If you do not provide one, Adaptive Server displays information about the current user. For example:

```
select user_name(10)
select user_name( )
select user_id("joe")
```

Displaying Information About Roles

Table 6-10 lists the system procedures and functions to use to find information about roles and the section in this chapter that provides details.

Table 6-10: Finding information about roles

To Display Information About	Use	See
The role ID of a role name	**role_id** system function	"Finding Role IDs and Names" on page 6-35
The role name of a role ID	**role_name** system function	"Finding Role IDs and Names" on page 6-35
System roles	**show_role** system function	"Viewing Active Roles" on page 6-35
Role hierarchies and roles that have been granted to a user or users	**sp_displayroles** system procedure	"Displaying a Role Hierarchy" on page 6-35
Whether one role contains another role in a role hierarchy	**role_contain** system function	"Viewing User Roles in a Hierarchy" on page 6-36
Whether two roles are mutually exclusive	**mut_excl_roles** system function	"Determining Mutual Exclusivity" on page 6-36
Roles that are active for the current session	**sp_activeroles** system procedure	"Determining Role Activation" on page 6-36

Table 6-10: Finding information about roles

To Display Information About	Use	See
Whether you have activated the correct role to execute a procedure	**proc_role** system function	"Checking for Roles in Stored Procedures" on page 6-36
Logins, including roles that have been granted	**sp_displaylogin** system procedure	"Getting Information About Login Accounts" on page 6-32

Finding Role IDs and Names

To find a role ID when you know the role name, use **role_id**:

```
role_id(role_name)
```

Any user can execute **role_id**. If the role is valid, **role_id** returns the server-wide ID of the role (*srid*). The *syssrvroles* system table contains an *srid* column with the role ID and a *name* column with the role name. If the role is not valid, **role_id** returns NULL.

To find a role name when you know the role ID, use **role_name**:

```
role_name(role_id)
```

Any user can execute **role_name**.

Viewing Active Roles

Use **show_role** to display the currently active **system roles** for the specified login:

```
show_role()
```

If you have not activated any system role, **show_role** returns NULL. If you are a Database Owner, and you execute **show_role** after using **setuser** to impersonate another user, **show_role** returns your own active system roles, not those for whom you are impersonating.

Any user can execute **show_role**.

➤ ***Note***

The **show_role** function does not give information about user-defined roles.

Displaying a Role Hierarchy

You can see all roles granted to your login name or see the entire hierarchy tree of roles displayed in table format using **sp_displayroles**:

```
sp_displayroles {login_name | rolename [, expand_up |
   expand_down]}
```

Any user can execute **sp_displayroles** to see his or her own roles. Only the System Security Officer or the System Administrator can view information about roles granted to other users.

Viewing User Roles in a Hierarchy

Use **role_contain** to determine whether any role you specify contains any other role you specify:

```
role_contain ("role1", "role2")
```

If *role1* contains *role2*, **role_contain** returns 1.

Any user can execute **role_contain**.

Determining Mutual Exclusivity

Use the **mut_excl_roles** function to determine whether any two roles assigned to you are mutually exclusive and the level at which they are mutually exclusive:

```
mut_excl(role1, role2, {membership | activation})
```

Any user can execute **mut_excl_roles**. If the specified roles, or any role contained by either specified role, are mutually exclusive, **mut_excl_roles** returns 1; if the roles are not mutually exclusive, **mut_excl_roles** returns 0.

Determining Role Activation

To find all active roles for the current login session of Adaptive Server, use **sp_activeroles**:

```
sp_activeroles [expand_down]
```

expand_down displays the hierarchy of all roles contained by any roles granted to you.

Any user can execute **sp_activeroles**.

Checking for Roles in Stored Procedures

Use **proc_role** within a stored procedure to guarantee that only users with a specific role can execute the procedure. Only **proc_role** provides a fail-safe way to prevent inappropriate access to a particular stored procedure.

You can use **grant execute** to grant execute permission on a stored procedure to all users who have been granted a specified role. Similarly, **revoke execute** removes this permission.

However, **grant execute** permission does not prevent users who do not have the specified role from being granted execute permission on a stored procedure. If you want to ensure, for example, that all users who are not System Administrators can never be granted permission to execute a stored procedure, use **proc_role** within the stored procedure itself. It checks to see whether the invoking user has the correct role to execute the procedure.

proc_role takes a string for the required role and returns 1 if the invoker possesses it. Otherwise, it returns 0.

For example, here is a procedure that uses **proc_role** to see if the user has the **sa_role** role:

```
create proc test_proc
as
if (proc_role("sa_role") = 0)
begin
    print "You don't have the right role"
    return -1
end
else
    print "You have System Administrator role"
    return 0
```

Monitoring License Use

The License Use Monitor allows a System Administrator to monitor the number of user licenses used in Adaptive Server and securely manage the license agreement data. That is, you can ensure that the number of licenses used on your Adaptive Server does not exceed the number specified in your license agreement.

The License Use Monitor tracks the number of licenses issued; it does not enforce the license agreement. If the License Use Monitor reports that you are using more user licenses than specified in your license agreement, see your Sybase sales representative.

You must have System Administrator privileges to configure the License Use Monitor.

By default, the License Use Monitor is turned off when Adaptive Server is first installed or upgraded. The System Administrator must configure the License Use Monitor to monitor license usage. See

““Configuring License Manager to Monitor User Licenses” on page 6-38 for configuration information.

How Licenses Are Counted

A license is of the combination of a host computer name and a user name. If a user logs in to Adaptive Server multiple times from the same host machine, it counts as one license. However, if the user logs in once from host A, and once from host B, it counts as two licenses. If multiple users log in to Adaptive Server from the same host, but with different user names, each distinct combination of user name and host name is counted.

Configuring License Manager to Monitor User Licenses

Use **sp_configure** to specify the number of licenses in your license agreement:

```
sp_configure "license information" , number
```

where *number* is the number of licenses. For example:

```
sp_configure "licenses information", 300
```

sets the maximum number of user licenses to 300, and reports an overuse for license number 301. If you increase the number of user licenses, you must also change the **license number** configuration parameter.

The configuration parameter **housekeeper free write percent** must be set to 1 or more in order for the License Manager to track license use.

Monitoring License Use with the Housekeeper Task

After you configure the License Use Monitor, the housekeeper task determines how many user licenses are in use, based on the user ID and the host name of each user logged in to Adaptive Server. When the housekeeper task checks licenses, the License Use Monitor updates a variable that tracks the maximum number of user licenses in use:

- If the number of licenses in use is the same or has decreased since the previous housekeeper run, the License Use Monitor does nothing

- If the number of licenses in use has increased since the previous housekeeper run, the License Use Monitor sets this number as the maximum number of licenses in use.
- If the number of licenses in use is greater than the number allowed by the license agreement, the License Use Monitor issues message to the error log:

  ```
  Exceeded license usage limit. Contact Sybase Sales
  for additional licenses.
  ```

The housekeeper task runs during Adaptive Server's idle cycles. The housekeeper monitors the number of user licenses only if the **housekeeper free write percent** configuration parameter is set to 1 or greater.

For more information about the housekeeper task, see Chapter 18, "System Administration Changes" and Chapter 21, "How Adaptive Server Uses Engines and CPUs," in the *Performance and Tuning Guide*.

Logging the Number of User Licenses

The *syblicenseslog* system table is created in the *master* database when you install or upgrade Adaptive Server. The License Use Monitor updates the columns in *syblicenseslog* at the end of each 24-hour period, as shown in Table 6-11.

Table 6-11: Columns in *syblicenseslog* table

Column	Description
status	-1 – Housekeeper unable to monitor licenses. 0 – Number of licenses not exceeded. 1 – Number of licensees exceeded.
logtime	Date and time the log information was inserted.
maxlicenses	Maximum number of licenses used during the previous 24 hours.

syblicenseslog looks similar to this:

```
status logdate                    maxlicenses
 ------ ------------------------- -----------
      0        Jul 17 1998 11:43AM         123
      0        Jul 18 1998 11:47AM         147
      1        Jul 19 1998 11:51AM         154
      0        Jul 20 1998 11:55AM         142
      0        Jul 21 1998 11:58AM         138
      0        Jul 21 1998  3:14PM         133
```

In this example, the number of user licenses used exceeded the limit on July 19, 1998.

If Adaptive Server is shut down, License Manager updates *syblicenseslog* with the current maximum number of licenses used. Adaptive Server starts a new 24-hour monitoring period when it is rebooted.

The second row for July 21, 1998 was caused by a shutdown and reboot of the server.

Getting Information About Usage: Chargeback Accounting

When a user logs in to Adaptive Server, the server begins accumulating CPU and I/O usage for that user. Adaptive Server can report total usage for an individual or for all users. Information for each user is kept in the *syslogins* system table in the *master* database.

Reporting Current Usage Statistics

The System Administrator can use **sp_reportstats** or **sp_clearstats** to get or clear current total usage data for individuals or for all users on Adaptive Server.

Displaying Current Accounting Totals

sp_reportstats displays current accounting totals for Adaptive Server users. It reports total CPU and total I/O, as well as the percentage of those resources used. It does not record statistics for the “sa” login (processes with an *suid* of 1), checkpoint, network, and mirror handlers.

Initiating a New Accounting Interval

Adaptive Server accumulates CPU and I/O statistics until you clear the totals from *syslogins* by running **sp_clearstats**. **sp_clearstats** initiates a new accounting interval for Adaptive Server users and executes **sp_reportstats** to print out statistics for the previous period.

Choose the length of your accounting interval by deciding how you want to use the statistics at your site. For example, to do monthly cross-department charging for the percentage of Adaptive Server CPU and I/O usage, the System Administrator would run **sp_clearstats** once a month.

For detailed information about these stored procedures, see the *Adaptive Server Reference Manual*.

Specifying the Interval for Adding Accounting Statistics

A System Administrator can use configuration parameters to decide how often accounting statistics are added to *syslogins*.

To specify how many machine clock ticks accumulate before accounting statistics are added to *syslogins*, use the **cpu accounting flush interval** configuration parameter. The default value is 200. For example:

```
sp_configure "cpu accounting flush interval", 600
```

To find out how many microseconds a tick is on your system, run the following query in Adaptive Server:

```
select @@timeticks
```

To specify how many read or write I/Os accumulate before the information is added (flushed) to *syslogins*, use the **i/o accounting flush interval** configuration parameter. The default value is 1000. For example:

```
sp_configure "i/o accounting flush interval", 2000
```

I/O and CPU statistics are flushed when a user accumulates more I/O or CPU usage than the specified value. The information is also flushed when the user exits an Adaptive Server session.

The minimum value allowed for either configuration parameter is 1. The maximum value allowed is 2,147,483,647.

7 Managing User Permissions

This chapter describes the use and implementation of user permissions. Topics include:

Overview

Discretionary access controls (DAC) allow you to restrict access to objects and commands based on a user's identity or group membership. The controls are "discretionary" because a user with a certain access permission, such as an object owner, can choose whether to pass that access permission on to other users.

System Administrators operate outside the DAC system and have access permissions on all database objects at all times. System Security Officers can always access the audit trail tables in the *sybsecurity* database.

Database Owners do not automatically receive permissions on objects owned by other users; however, they can:

- Temporarily acquire all permissions of a user in the database by using the **setuser** command to assume the identity of that user.
- Permanently acquire permission on a specific object by using the **setuser** command to assume the identity of the object owner, and then using **grant** commands to grant the permissions.

For details on assuming another user's identity to acquire permissions on a database or object, see "Acquiring the Permissions of Another User" on page 7-20.

Object Owners can grant access to those objects to other users and can also grant other users the ability to pass the access permission to

other users. You can give various permissions to users, groups, and roles with the **grant** command, and rescind them with the **revoke** command. Use these commands to give users permission to create databases, to create objects within a database, execute certain commands such as **set proxy**, and to access specified tables, views, and columns. For permissions that default to "public," no **grant** or **revoke** statements are needed.

Some commands can be used at any time by any user, with no permission required. Others can be used only by users of a particular status and they are not transferable.

The ability to assign permissions for the commands that can be granted and revoked is determined by each user's role or status (as System Administrator, Database Owner, or database object owner), and by whether the user was granted a role with permission that includes the option to grant that permission to other users.

You can also use views and stored procedures as security mechanisms. See "Using Views and Stored Procedures As Security Mechanisms" on page 7-29.

Types of Users and Their Privileges

Adaptive Server's discretionary access control system recognizes the following types of users:

- System Administrators
- System Security Officers
- Operators
- Database Owners
- Database object owners
- Other users (also known as "public")

System Administrator Privileges

System Administrators:

- Handle tasks that are not specific to applications
- Work outside Adaptive Server's discretionary access control system

The role of System Administrator is usually granted to individual Adaptive Server logins. All actions taken by that user can be traced

to his or her individual server user ID. If the server administration tasks at your site are performed by a single individual, you may instead choose to use the "sa" account that is installed with Adaptive Server. At installation, the "sa" account user has permission to assume the System Administrator, System Security Officer, and Operator roles. Any user who knows the "sa" password can log in to that account and assume any or all of these roles.

The fact that a System Administrator operates outside the protection system serves as a safety precaution. For example, if the Database Owner accidentally deletes all the entries in the *sysusers* table, the System Administrator can restore the table (as long as backups exist). There are several commands that can be issued only by a System Administrator. They include **disk init**, **disk refit**, **disk reinit**, **shutdown**, **kill**, and the disk mirroring commands.

In granting permissions, a System Administrator is treated as the object owner. If a System Administrator grants permission on another user's object, the owner's name appears as the grantor in *sysprotects* and in **sp_helprotect** output.

In addition, System Administrators are responsible for dropping logins and can lock and unlock logins. System Security Officers share login management responsibilities with System Administrators. System Security Officers are responsible for adding logins and can also lock and unlock logins.

Permissions for Creating Databases

Only a System Administrator can grant permission to use the **create database** command. The user that receives **create database** permission must also be a valid user of the *master* database because all databases are created while using *master*.

In many installations, the System Administrator maintains a monopoly on **create database** permission to centralize control of database placement and database device space allocation. In these situations, a System Administrator creates new databases on behalf of other users, and then transfers ownership to the appropriate user.

To create a database that is to be owned by another user:

1. Issue the **create database** command in the *master* database.
2. Switch to the new database with the **use** command.
3. Execute **sp_changedbowner**.

System Security Officer Privileges

System Security Officers perform security-sensitive tasks in Adaptive Server, including:

- Granting the System Security Officer and Operator roles
- Administering the audit system
- Changing passwords
- Adding new logins
- Locking and unlocking login accounts
- Creating and granting user-defined roles
- Administering network-based security
- Granting permission to use the **set proxy** or **set session authorization** commands

The System Security Officer can **access** any database – to enable auditing – but, in general, has no special permissions on database objects. An exception is the *sybsecurity* database, where only a System Security Officer can access the *sysaudits* table. There are also several system procedures that can be executed only by a System Security Officer.

System Security Officers can repair any damage inadvertently done to the protection system by a user. For example, if the Database Owner forgets his or her password, a System Security Officer can change the password to allow the Database Owner to log in.

System Security Officers can also create and grant user-defined roles to users, other roles, or groups. For information about creating and granting user-defined roles, see Chapter 6, “Creating and Assigning Roles to Users.”

Operator Privileges

Users who have been granted the Operator role can back up and restore databases on a server-wide basis without having to be the owner of each database. The Operator role allows a user to use these commands on any database:

dump database
dump transaction
load database
load transaction

Database Owner Privileges

Database Owners and System Administrators are the only users who can grant object creation permissions to other users. The Database Owner has full privileges to do anything inside that database, and must explicitly grant permissions to other users with the **grant** command.

Permission to use these commands is automatically granted to the Database Owner and cannot be transferred to other users:

checkpoint
dbcc
drop database
dump database
dump transaction
grant (object creation permissions)
load database
load transaction
revoke (object creation permissions)
setuser

Database Owners can grant permission to use these commands to other users:

create default
create procedure
create rule
create table
create view
grant (permissions on system tables)
grant (**select, insert, delete, update, references,** and **execute** permissions on database objects)
revoke (permissions on system tables)
revoke (**select, insert, delete, update, references,** and **execute** permissions on database objects)

Permissions on System Tables

Permissions for use of the system tables can be controlled by the Database Owner, just like permissions on any other tables. By default, when Adaptive Server is installed, the **installmodel** script grants **select** access to "public" (all users) for most system tables and for most fields in the tables. However, no access is given for some system tables, such as *systhresholds*, and no access is given for certain

fields in other system tables. For example, all users, by default, can select all columns of *sysobjects* except *audflags*.

To determine the current permissions for a particular system table, execute:

```
sp_helprotect system_table_name
```

For example, to check the permissions of *systhresholds* in *your_database*, execute:

```
use your_database
go
sp_helprotect systhresholds
go
```

The default situation is that no users—including Database Owners—can modify the system tables directly. Instead, the system procedures supplied with Adaptive Server modify the system tables. This helps guarantee integrity.

◆ ***WARNING!***

Although does provide a mechanism that allows you to modify system tables, Sybase strongly recommends that you do not do so.

Permissions on System Procedures

Permissions on system procedures are set in the *sybsystemprocs* database, where the system procedures are stored.

Security-related system procedures can be run only by System Security Officers. Certain other system procedures can be run only by System Administrators.

Some of the system procedures can be run only by Database Owners. These procedures make sure that the user executing the procedure is the owner of the database from which they are being executed.

Other system procedures can be executed by any user who has been granted permission. A user must have permission to execute a system procedure in all databases, or in none of them.

Users who are not listed in *sybsystemprocs..sysusers* are treated as "guest" in *sybsystemprocs*, and are automatically granted permission on many of the system procedures. To deny a user permission on a system procedure, the System Administrator must add him or her to *sybsystemprocs..sysusers* and issue a **revoke** statement that applies to that procedure. The owner of a user database cannot directly control

permissions on the system procedures from within his or her own database.

Changing Database Ownership

Use **sp_changedbowner** to change the ownership of a database. Often, System Administrators create the user databases, then give ownership to another user after some of the initial work is complete. Only the System Administrator can execute **sp_changedbowner.**

It is a good idea to transfer ownership before the user has been added to the database, and before the user has begun creating objects in the database. The new owner must already have a login name on Adaptive Server, but cannot be a user of the database, or have an alias in the database. You may have to use **sp_dropuser** or **sp_dropalias** before you can change a database's ownership, and you may have to drop objects before you can drop the user.

Issue **sp_changedbowner** in the database whose ownership will be changed. The syntax is:

```
sp_changedbowner loginame [, true ]
```

This example makes "albert" the owner of the current database and drops aliases of users who could act as the old "dbo:"

```
sp_changedbowner albert
```

To transfer aliases and their permissions to the new "dbo," add the value **true** parameters.

➤ ***Note***

You cannot change the ownership of the *master* database and should not change the ownership of any other system databases.

Database Object Owner Privileges

A user who creates a database object (a table, view, or stored procedure) owns the object and is automatically granted all object access permissions on it. Users other than the object owner, including the owner of the database, are automatically denied all permissions on that object, unless they are explicitly granted by either the owner or a user who has **grant** permission on that object.

As an example, suppose that Mary is the owner of the *pubs2* database, and has granted Joe permission to create tables in it. Now

Joe creates the table *new_authors*; he is the owner of this database object.

Initially, object access permissions on *new_authors* belong only to Joe. Joe can grant or revoke object access permissions for this table to other users.

The following object creation permissions default to the owner of a table and cannot be transferred to other users:

alter table
drop table
create index
create trigger
truncate table
update statistics

Permission to use the **grant** and **revoke** commands to grant specific users **select, insert, update, delete, references,** and **execute** permissions on specific database objects can be transferred, using the **grant with grant option** command.

Permission to **drop** an object—a table, view, index, stored procedure, rule, or default—defaults to the object owner and cannot be transferred.

Privileges of Other Database Users

At the bottom of the hierarchy are other database users. Permissions are granted to or revoked from them by object owners, Database Owners, users who were granted permissions, or a System Administrator. These users are specified by user name, group name, or the keyword **public**.

Granting and Revoking Permissions on Database Objects

Two types of permissions exist for objects:

- **Object access permissions** – For using the commands that access database objects. For more information, see "Granting and Revoking Object Access Permissions" on page 7-9.
- **Object creation permissions** – For creating objects. They can be granted only by a System Administrator or a Database Owner. For more information, see "Granting and Revoking Object Creation Permissions" on page 7-14.

Both types of permissions are controlled with the **grant** and **revoke** commands.

Each database has its own independent protection system. Having permission to use a certain command in one database does not give you permission to use that command in other databases.

Granting and Revoking Object Access Permissions

Object access permissions regulate the use of certain commands that access certain database objects. For example, you must explicitly be granted permission to use the **select** command on the *authors* table. Object access permissions are granted and revoked by the object owner (and System Administrators), who can grant them to other users.

Table 7-1 lists the types of object access permissions and the objects to which they apply.

Table 7-1: Permissions and the objects to which they apply

Permission	Object
select	Table, view, column
update	Table, view, column
insert	Table, view
delete	Table, view
references	Table, column
execute	Stored procedure

The **references** permission refers to referential integrity constraints that you can specify in an **alter table** or **create table** command. The other permissions refer to SQL commands.Object access permissions default to System Administrators and the object's owner, and can be granted to other users.

Use the **grant** command to grant object access permissions. The syntax is:

```
grant {all [privileges]| permission_list}
   on { table_name [(column_list)]
        | view_name[(column_list)]
        | stored_procedure_name}
   to {public | name_list | role_name}
   [with grant option]
```

Use the **revoke** command to revoke object access permissions. The syntax is:

```
revoke [grant option for]
   {all [privileges] | permission_list}
   on { table_name [(column_list)]
       | view_name [(column_list)]
       | stored_procedure_name}
   from {public | name_list | role_name}
   [cascade]
```

Notes on the keywords and parameters are as follows:

- **all** or **all privileges** specifies all permissions applicable to the specified object. All object owners can use **all** with an object name to grant or revoke permissions on their own objects. If you are granting or revoking permissions on a stored procedure, **all** is the same as **execute**.

➤ *Note*

insert and **delete** permissions do not apply to columns, so you cannot include them in a permission list (or use the keyword **all**) if you specify a column list.

- *permission_list* is the list of permissions that you are granting. If you name more than one permission, separate them with commas. Table 7-2 illustrates the access permissions that can be granted on each type of object:

Table 7-2: Object access permissions

Object	*permission_list* Can Include
Table or view	**select**, **insert**, **delete**, **update**, **references.** **references** applies to tables but not views; the other permissions apply to both tables and views.
Column	**select**, **update**, **references**
Stored procedure	**execute**

  You can specify columns in the *permission_list* or the *column_list*, but not both.

- **on** specifies the object for which the permission is being granted or revoked. You can grant or revoke permissions for only one table, view, or stored procedure object at a time. You can grant or revoke permissions for more than one column at a time, but all

the columns must be in the same table or view. You can only grant or revoke permissions on objects in your current database.

- **public** refers to the group "public," which includes all Adaptive Server users. **public** means slightly different things for **grant** and **revoke**:
  - For **grant**, **public** includes the object owner. Therefore, if you have revoked permissions from yourself on your object, and later you **grant** permissions to **public**, you regain the permissions along with the rest of "public."
  - For **revoke**, **public** excludes the owner.
- *name_list* includes:
  - Group names
  - User names
  - A combination of user and group names, each separated from the next by a comma
- *role_name* is an Adaptive Server system-defined or user-defined role. You can create and define a hierarchy of user-defined roles and grant them privileges based on the specific role granted. System-defined roles include **sa_role** (System Administrator), **sso_role** (System Security Officer), and **oper_role** (Operator). You cannot create or modify system-defined roles.
- **with grant option** in a **grant** statement allows the user(s) specified in *name_list* to grant the specified object access permission(s) to other users. If a user has **with grant option** permission on an object, that permission is not revoked when permissions on the object are revoked from **public** or a group of which the user is a member.
- **grant option for** revokes **with grant option** permissions, so that the user(s) specified in *name_list* can no longer grant the specified permissions to other users. If those other users have granted permissions to other users, you must use the **cascade** option to revoke permissions from them as well. The user specified in *name_list* retains permission to access the object, but can no longer grant access to other users. **grant option for** applies only to object access permissions, not to object creation permissions.
- The **cascade** option in a **revoke** statement removes the specified object access permissions from the user(s) specified in *name_list*, and also from any users they granted those permissions to.

You may only grant and revoke permissions on objects in the current database.

If several users grant access to an object to a particular user, the user's access remains until access is revoked by all those who granted access or until a System Administrator revokes the access. That is, if a System Administrator revokes access, the user is denied access even though other users have granted access.

Permission to issue the **create trigger** command is granted to users by default. When you revoke permission for a user to create triggers, a revoke row is added in the *sysprotects* table for that user. To grant permission to issue **create trigger**, you must issue two grant commands. The first command removes the revoke row from *sysprotects*; the second inserts a grant row. If you revoke permission to create triggers, the user cannot create triggers even on tables that the user owns. Revoking permission to create triggers from a user affects only the database where the revoke command was issued. Only a System Security Officer can grant or revoke permissions to create triggers.

Special Requirements for SQL92 Standard Compliance

When you have used the **set** command to turn **ansi_permissions** on, additional permissions are required for **update** and **delete** statements. Table 7-3 summarizes the required permissions.

Table 7-3: ANSI permissions for update and delete

	Permissions Required: *set ansi_permissions off*	Permissions Required: *set ansi_permissions on*
update	**update** permission on columns where values are being set	**update** permission on columns where values are being set and **select** permission on all columns appearing in the **where** clause **select** permission on all columns on the right side of the **set** clause
delete	**delete** permission on the table	**delete** permission on the table from which rows are being deleted and **select** permission on all columns appearing in the **where** clause

If **ansi_permissions** is on and you attempt to update or delete without having all the additional **select** permissions, the transaction is rolled

back and you receive an error message. If this occurs, the object owner must grant you **select** permission on all relevant columns.

Examples of Granting Object Access Permissions

This statement gives Mary and the "sales" group permission to insert into and delete from the *titles* table:

```
grant insert, delete
on titles
to mary, sales
```

This statement gives Harold permission to use the stored procedure **makelist**:

```
grant execute
on makelist
to harold
```

This statement grants permission to execute the custom stored procedure **sa_only_proc** to users who have been granted the System Administrator role:

```
grant execute
on sa_only_proc
to sa_role
```

This statement gives Aubrey permission to select, update, and delete from the *authors* table and to grant the same permissions to other users:

```
grant select, update, delete
on authors
to aubrey
with grant option
```

Examples of Revoking Object Access Permissions

These two statements both revoke permission for all users except the table owner to update the *price* and *total_sales* columns of the *titles* table:

```
revoke update
on titles (price, total_sales)
from public
```

```
revoke update(price, total_sales)
on titles
from public
```

This statement revokes permission from Clare to update the *authors* table and simultaneously revokes that permission from all users to whom she had granted that permission:

```
revoke update
on authors
from clare
cascade
```

This statement revokes permission from operators to execute the custom stored procedure **new_sproc**:

```
revoke execute
on new_sproc
from oper_role
```

Granting and Revoking Object Creation Permissions

Object creation permissions regulate the use of commands that create objects. These permissions can be granted only by a System Administrator or a Database Owner.

The object creation commands are:

create database
create default
create procedure
create rule
create table
create view

The syntax for object creation permissions differs slightly from the syntax for object access permissions. The syntax for **grant** is:

```
grant {all [privileges] | command_list}
   to {public | name_list | role_name}
```

The syntax for **revoke** is:

```
revoke {all [privileges] | command_list}
   from {public | name_list | role_name}
```

where:

- **all** or **all privileges** can be used only by a System Administrator or the Database Owner. When used by a System Administrator in the *master* database, **grant all** assigns all **create** permissions, including **create database**. If the System Administrator executes **grant all** from another database, all **create** permissions are granted except **create database**. When the Database Owner uses **grant all**,

Adaptive Server grants all **create** permissions except **create database**, and prints an informational message.

- *command_list* is the object creation permissions that you are granting or revoking. Separate commands with commas. The list can include **create database**, **create default**, **create procedure**, **create rule**, **create table**, and **create view. create database** permission can be granted only by a System Administrator, and only from within the *master* database.
- **public** is all users except the Database Owner (who "owns" object creation permissions within the database).
- *name_list* is a list of user or group names, separated by commas.
- *role_name* is the name of an Adaptive Server system or user-defined role. You can create and define a hierarchy of user-defined roles and grant them privileges based on the specific role granted.

Examples of Granting Object Creation Permissions

The first example grants Mary and John permission to use **create database** and **create table.** Because **create database** permission is being granted, this command can only be executed by a System Administrator within the *master* database. Mary and John's **create table** permission applies only to the *master* database.

```
grant create table, create database
to mary, john
```

This command grants permission to create tables and views in the current database to all users:

```
grant create table, create view
to public
```

Example of Revoking Object Creation Permissions

This example revokes permission to create tables and rules from "mary:"

```
revoke create table, create rule
from mary
```

Combining *grant* and *revoke* Statements

You can assign specific permissions to specific users, or, if most users are going to be granted most privileges, it may be easier to assign all permissions to all users, and then revoke specific permissions from specific users.

For example, a Database Owner can grant all permissions on the *titles* table to all users by issuing:

```
grant all
on titles
to public
```

The Database Owner can then issue a series of **revoke** statements, for example:

```
revoke update
on titles (price, advance)
from public

revoke delete
on titles
from mary, sales, john
```

grant and **revoke** statements are order-sensitive: in case of a conflict, the most recently issued statement supersedes all others.

➤ ***Note***

Under SQL rules, you must use the **grant** command before using the **revoke** command, but the two commands cannot be used within the same transaction. Therefore, when you grant "public" access to objects, and then revoke that access from an individual, there is a short period of time during which the individual has access to the objects in question. To prevent this situation, use the **create schema** command to include the **grant** and **revoke** clauses within one transaction.

Understanding Permission Order and Hierarchy

grant and **revoke** statements are sensitive to the order in which they are issued. For example, if Jose's group has been granted **select** permission on the *titles* table and then Jose's permission to **select** the *advance* column has been revoked, Jose can **select** all the columns except *advance*, while the other users in his group can still **select** all the columns.

A **grant** or **revoke** statement that applies to a group or role changes any conflicting permissions that have been assigned to any member of that group or role. For example, if the owner of the *titles* table has granted different permissions to various members of the *sales* group, and wants to standardize, he or she might issue the following statements:

```
revoke all on titles from sales
grant select on titles(title, title_id, type,
        pub_id)
    to sales
```

Similarly, a **grant** or **revoke** statement issued to **public** will change, for all users, all previously issued permissions that conflict with the new regime.

The same **grant** and **revoke** statements issued in different orders can create entirely different situations. For example, the following set of statements leaves Jose, who belongs to the **public** group, without any **select** permission on *titles*:

```
grant select on titles(title_id, title) to jose
revoke select on titles from public
```

In contrast, the same statements issued in the opposite order result in only Jose having **select** permission and only on the *title_id* and *title* columns:

```
revoke select on titles from public
grant select on titles(title_id, title) to jose
```

When you use the keyword **public** with **grant**, you are including yourself. With **revoke** on object creation permissions, you are included in **public** unless you are the Database Owner. With **revoke** on object access permissions, you are included in **public** unless you are the object owner. You may want to deny yourself permission to use your own table, while giving yourself permission to access a view built on it. To do this, you must issue **grant** and **revoke** statements explicitly setting your permissions. You can reinstitute the permission with a **grant** statement.

Granting and Revoking Roles

After a role is defined, it can be granted to any login account or role in the server, provided that it does not violate the rules of mutual

exclusivity and hierarchy. Table 7-4 lists the tasks related to roles, the role required to perform the task, and the command to use.

Table 7-4: Tasks, required roles, and commands to use

Task	Required Role	Command
Grant the **sa_role** role	System Administrator	**grant role**
Grant the **sso_role** role	System Security Officer	**grant role**
Grant the **oper_role** role	System Security Officer	**grant role**
Grant user-defined roles	System Security Officer	**grant role**
Create role hierarchies	System Security Officer	**grant role**
Modify role hierarchies	System Security Officer	**revoke role**
Revoke system roles	System Security Officer	**revoke role**
Revoke user-defined roles	System Security Officer	**revoke role**

Granting Roles

To grant roles to users or other roles, use:

```
grant role role_granted [{, role_granted}...]
   to grantee [{, grantee}...]
```

where:

- *role_granted* is the role being granted. You can specify any number of roles to be granted.
- *grantee* is the name of the user or role. You can specify any number of grantees.

All roles listed in the **grant** statement are granted to all grantees. If you grant one role to another, it creates a role hierarchy.

For example, to grant Susan, Mary, and John the “financial_analyst” and the “payroll_specialist” roles, enter:

```
grant role financial_analyst, payroll_specialist
  to susan, mary, john
```

Understanding *grant* and Roles

You can use the **grant** command to grant permission on objects to all users who have been granted a specified role, whether system or

user-defined. This allows you to restrict use of an object to users who have been granted any of these roles:

- System Administrator
- System Security Officer
- Operator
- Any user-defined role

You can also use the **grant** command to grant a role to a user, another role or roles, or a group.

However, **grant** permission does not prevent users who do **not** have the specified role from being granted execute permission on a stored procedure. If you want to ensure, for example, that only System Administrators can successfully execute a stored procedure, use the **proc_role** system function within the stored procedure itself. See "Displaying Information About Roles" on page 6-34 for more information.

Permissions granted to roles override permissions granted to users or groups. For example, assume John has been granted the System Security Officer role, and **sso_role** has been granted permission on the *sales* table. If John's individual permission on *sales* is revoked, he is still able to access *sales* when he has **sso_role** active because his role permissions override his individual permissions.

In granting permissions, a System Administrator is treated as the object owner. If a System Administrator grants permission on another user's object, the owner's name appears as the grantor in *sysprotects* and in **sp_helpprotect** output.

If several users grant access to an object to a particular user, the user's access remains until access is revoked by all those who granted access. If a System Administrator revokes access, the user is denied access, even though other users have granted access.

Revoking Roles

Use **revoke role** to revoke roles from users and other roles:

```
revoke role role_name [{, role_name}...]from grantee
   [{, grantee}...]
```

where:

- *role_name* is the role being revoked. You can specify any number of roles to be revoked.

- *grantee* is the name of the user or role. You can specify any number of grantees.

All roles listed in the **revoke** statement are revoked from all grantees.

You cannot revoke a role from a user while the user is logged in.

Acquiring the Permissions of Another User

Adaptive Server provides two ways of acquiring another user's identity and permissions status:

- A Database Owner can use the **setuser** command to "impersonate" another user's identity and permissions status in the current database. See "Using setuser" on page 7-20.
- **proxy authorization** allows one user to assume the identity of another user on a server-wide basis. See "Using Proxy Authorization" on page 7-21.

Using setuser

A Database Owner may use **setuser** to:

- Access an object owned by another user
- Grant permissions on an object owned by another user
- Create an object that will be owned by another user
- Temporarily assume the DAC permissions of another user for some other reason

While the **setuser** command enables the Database Owner to automatically acquire another user's DAC permissions, the command does not affect the roles that have been granted.

setuser permission defaults to the Database Owner and cannot be transferred. The user being impersonated must be an authorized user of the database. Adaptive Server checks the permissions of the user being impersonated.

System Administrators can use **setuser** to create objects that will be owned by another user. However, System Administrators operate outside the DAC permissions system; therefore, they need not use **setuser** to acquire another user's permissions. The **setuser** command remains in effect until another **setuser** command is given, the current database is changed, or the user logs off.

The syntax is:

```
setuser ["user_name"]
```

where *user_name* is a valid user in the database that is to be impersonated.

To reestablish your original identity, use **setuser** with no value for *user_name*.

This example shows how the Database Owner would grant Joe permission to read the *authors* table, which is owned by Mary:

```
setuser "mary"

grant select on authors to joe

setuser     /*re-establishes original identity*/
```

Using Proxy Authorization

With the proxy authorization capability of Adaptive Server, System Security Officers can grant selected logins the ability to assume the security context of another user, and an application can perform tasks in a controlled manner on behalf of different users. If a login has permission to use proxy authorization, the login can impersonate any other login in Adaptive Server.

◆ ***WARNING!***

The ability to assume another user's identity is extremely powerful and should be limited to trusted administrators and applications. A user with this permission can even assume the identity of the "sa" login, and, thereby, have unlimited power within Adaptive Server.

A user executing **set proxy** or **set session authorization** operates with both the login name and server user ID of the user being impersonated. The login name is stored in the *name* column of *master..syslogins* and the server user ID is stored in the *suid* column of *master..syslogins*. These values are active across the entire server in all databases.

➤ ***Note***

set proxy and **set session authorization** are identical in function and can be used interchangeably. The only difference between them is that **set session authorization** is ANSI SQL92 compatible, and **set proxy** is a Transact-SQL extension.

Granting Proxy Authorization

System Security Officers use the **grant set proxy** or **grant set session authorization** command to give a user permission to impersonate another user within the server. The user with this permission can then execute either **set proxy** or **set session authorization** to become another user.

To grant proxy authorization permission, you must be a System Security Officer and execute the **grant** command from the *master* database. The syntax is:

```
grant set proxy
   to {public | name_list | role_name}
```

or

```
grant set session authorization
   to {public | name_list | role_name}
```

where:

- *public* is all users. Sybase recommends that you not grant this permission to "public."
- *role_name* is an Adaptive Server system or user-defined role. You can grant permissions to users based on the specific role granted.
- *name_list* is user database or group names, separated by commas. The user must be a valid user in the *master* database.

To grant **set proxy** to an application with the login "appl" if you do not have **sso_role** currently active, and you are not in the *master* database, execute:

```
use master
go
set role sso_role on
go
grant set proxy to appl
go
```

To grant **set proxy** to that user-defined role "accountant," execute:

```
grant set proxy to accountant
```

To grant **set session authorization** to the "sa" account, whose user name in every database is "dbo," execute:

```
grant set proxy to dbo
```

Executing Proxy Authorization

Follow these rules when you execute **set proxy** or **set session authorization**:

- You cannot execute **set proxy** or **set session authorization** from within a transaction.
- You can execute **set proxy** or **set session authorization** from any database that you are allowed to use. However, the *login_name* you specify must be a valid user in the database, or the database must have a "guest" user defined for it.
- Only one level is permitted; to impersonate more than one user, you must return to your original identity between impersonations.
- If you execute **set proxy** or **set session authorization** from within a procedure, your original identity is automatically resumed when you exit the procedure.

If you have a login that has been granted permission to use **set proxy** or **set session authorization**, you can set proxy to impersonate another user. The syntax is:

```
set proxy login_name
```

or

```
set session authorization login_name
```

where *login_name* is the name of a valid login in *master..syslogins*. Enclose the login name in quotation marks.

For example, to set proxy to "mary," execute:

```
set proxy mary
```

After setting proxy, check your login name in the server and your user name in the database. For example, assume that your login is "ralph" and that you have been granted **set proxy** authorization. You want to execute some commands as "sallyn" and as "rudolph" in *pubs2* database. "sallyn" has a valid name ("sally") in the database, but Ralph and Rudolph do not. However, *pubs2* has a guest user defined. You can execute:

```
set proxy "sallyn"
go
use pubs2
go
select suser_name(), user_name()
go
```

```
------------------------------ ------------------
sallyn                         sally
```

To change to Rudolph, you must first change back to your own identity. To do so, execute:

```
set proxy "ralph"
select suser_name(), user_name()
go
------------------------------ --------------------
ralph                          guest
```

Notice that Ralph is a "guest" in the database.

Then execute:

```
set proxy "rudolph"
go
select suser_name(), user_name()
go
------------------------------ --------------------
rudolph                        guest
```

Rudolph is also a guest in the database because Rudolph is not a valid user in the database.

Now, impersonate the "sa" account. Execute:

```
set proxy "ralph"
go
set proxy "sa"
go
select suser_name(), user_name()
go
-------------------------- --------------------
sa                         dbo
```

Proxy Authorization for Applications

Figure 7-1 shows an application server logging in to Adaptive Server with the generic login "appl" to execute procedures and commands for several users. While "appl" impersonates Tom, the application has Tom's permissions. Likewise, when "appl" impersonates Sue

and John, the application has only Sue's and John's permissions, respectively.

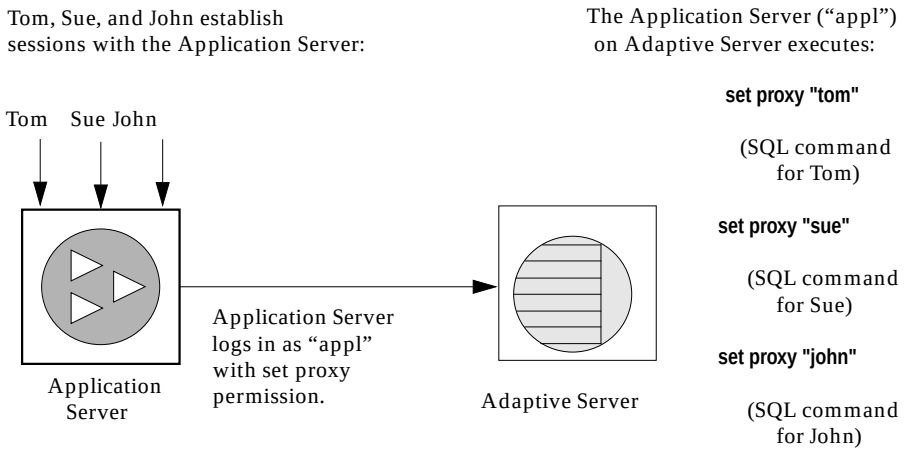

Figure 7-1: Applications and proxy authorization

Reporting on Permissions

Table 7-5 lists the system procedures for reporting information about proxies, object creation and object access permissions:

Table 7-5: System procedures for reporting on permissions

To Report Information On	Use
Proxies	system tables
Users and processes	**sp_who**
Permissions on database objects or users	**sp_helprotect**
Permissions on specific tables	**sp_table_privileges**
Permissions on specific columns in a table	**sp_column_privileges**

Querying the *sysprotects* Table for Proxy Authorization

To display information about permissions that have been granted to, or revoked from, users, groups, and roles, query the *sysprotects* table.

The *action* column specifies the permission. For example, the *action* value for **set proxy** or **set session authorization** is equal to 167.

You might execute this query:

```
select * from sysprotects where action = 167
```

The results provide the user ID of the user who granted or revoked the permission (column *grantor*), the user ID of the user who has the permission (column *uid*), and the type of protection (column *protecttype*). The *protecttype* column can contain these values:

- 0 for **grant with grant**
- 1 for **grant**
- 2 for **revoke**

For more information about the *sysprotects* table, see the *Adaptive Server Reference Manual*.

Displaying Information about Users and Processes

sp_who displays information about all current Adaptive Server users and processes or about a particular user or process. The results of **sp_who** include the *loginame* and *origname*. If a user is operating under a proxy, *origname* contains the name of the original login. For example, assume that "ralph" executed:

```
set proxy susie
```

and then executes some SQL commands.

sp_who returns "susie" for *loginame* and "ralph" for *origname*.

sp_who queries the *master..sysprocesses* system table, which contains columns for the server user ID (*suid*) and the original server user ID (*origsuid*).

For more information, see **sp_who** in the *Adaptive Server Reference Manual*.

Reporting Permissions on Database Objects or Users

Use **sp_helprotect** to report on permissions by database object or by user, and (optionally) by user for a specified object. Any user can execute this procedure. The syntax is:

```
sp_helprotect [name [, username [, "grant"
   [,"none"|"granted"|"enabled"|role_name]]]]
```

where:

name is either the name of the table, view, or stored procedure, or the name of a user, group, or role in the current database. If you do not provide a name, **sp_helprotect** reports on all permissions in the database.

username is a user's name in the current database.

If you specify *username*, only that user's permissions on the specified object are reported. If *name* is not an object, **sp_helprotect** checks whether *name* is a user, group, or role and if it is, lists the permissions for the user, group, or role. If you specify keyword **grant**, and *name* is not an object, **sp_helprotect** displays all permissions granted by **with grant option.**

grant displays the permissions granted to *name* **with grant option**.

none ignores roles granted to the user.

granted includes information on all roles granted to the user.

enabled includes information on all roles activated by the user.

role_name displays permission information for the specified role only, regardless of whether this role has been granted to the user.

For example, suppose you issue the following series of **grant** and **revoke** statements:

```
grant select on titles to judy
grant update on titles to judy
revoke update on titles(contract) from judy
grant select on publishers to judy
    with grant option
```

To determine the permissions Judy now has on each column in the *titles* table, enter:

```
sp_helprotect titles, judy
```

```
grantor grantee type   action   object     column      grantable
------- ------ -----   ------   ------     ------      -------
dbo     judy   Grant   Select   titles     All         FALSE
dbo     judy   Grant   Update   titles     advance     FALSE
dbo     judy   Grant   Update   titles     notes       FALSE
dbo     judy   Grant   Update   titles     price       FALSE
dbo     judy   Grant   Update   titles     pub_id      FALSE
dbo     judy   Grant   Update   titles     pubdate     FALSE
dbo     judy   Grant   Update   titles     title       FALSE
dbo     judy   Grant   Update   titles     title_id    FALSE
dbo     judy   Grant   Update   titles     total_sales FALSE
dbo     judy   Grant   Update   titles     type        FALSE
```

The first row shows that the Database Owner ("dbo") gave Judy permission to select all columns of the *titles* table. The rest of the lines indicate that she can update only the columns listed in the display. Judy cannot give **select** or **update** permissions to any other user.

To see Judy's permissions on the *publishers* table, enter:

```
sp_helprotect publishers, judy
```

In this display, the *grantable* column indicates TRUE, meaning that Judy can grant the permission to other users.

```
grantor grantee type   action   object     column      grantable
------- ------ -----   ------   ------     ------      -------
dbo     judy   Grant   Select   publishers all         TRUE
```

Reporting Permissions on Specific Tables

Use **sp_table_privileges** to return permissions information about a specified table. The syntax is:

```
sp_table_privileges table_name [, table_owner
   [, table_qualifier]]
```

where:

- *table_name* is the name of the table. It is required.
- *table_owner* can be used to specify the name of the table owner, if it is not "dbo" or the user executing **sp_table_privileges**.
- *table_qualifier* is the name of the current database.

Use **null** for parameters that you want to skip.

For example, the following statement:

```
sp_table_privileges titles
```

returns information about all permissions granted on the *titles* table. For more information about the output of **sp_table_privileges** see the *Adaptive Server Reference Manual*.

Reporting Permissions on Specific Columns

Use **sp_column_privileges** to return information about permissions on columns in a table. The syntax is:

```
sp_column_privileges table_name [, table_owner
   [, table_qualifier [, column_name]]]
```

where:

- *table_name* is the name of the table.
- *table_owner* can be used to specify the name of the table owner, if it is not "dbo" or the user executing **sp_column_privileges**.
- *table_qualifier* is the name of the current database.
- *column_name* is the name of the column on which you want to see permissions information.

Use **null** for parameters that you want to skip.

For example, the following statement:

```
sp_column_privileges publishers, null, null, pub_id
```

returns information about the *pub_id* column of the *publishers* table. For more information about the output of **sp_column_privileges**, see the *Adaptive Server Reference Manual*.

Using Views and Stored Procedures As Security Mechanisms

Views and stored procedures can serve as security mechanisms. You can give users controlled access to database objects via a view or stored procedure without granting them direct access to the data. For example, you might give a clerk **execute** permission on a procedure that updates cost information in a *projects* table without letting the user see confidential data in the table. To use this feature, you must own the procedure or view as well as its underlying objects. If you do not own the underlying objects, users must have permission to access the objects. For more information about when permissions are required, see "Understanding Ownership Chains" on page 7-33.

Adaptive Server makes permission checks, as required, when the view or procedure is used. When you create the view or procedure,

Adaptive Server makes no permission checks on the underlying objects.

Using Views As Security Mechanisms

Through a view, users can query and modify only the data they can see. The rest of the database is neither visible nor accessible.

Permission to access the view must be explicitly granted or revoked, regardless of the permissions on the view's underlying tables. If the view and underlying tables are owned by the same owner, no permissions need to be given to the underlying tables. Data in an underlying table that is not included in the view is hidden from users who are authorized to access the view but not the underlying table.

By defining different views and selectively granting permissions on them, a user (or any combination of users) can be restricted to different subsets of data. Access can be restricted to:

- A subset of the rows of a base table (a value-dependent subset). For example, you might define a view that contains only the rows for business and psychology books to keep information about other types of books hidden from some users.
- A subset of the columns of a base table (a value-independent subset). For example, you might define a view that contains all the rows of the *titles* table, but omits the *price* and *advance* columns, since this information is sensitive.
- A row-and-column subset of a base table.
- The rows that qualify for a join of more than one base table. For example, you might define a view that joins the *titles*, *authors*, and *titleauthor* tables. This view would hide personal data about authors and financial information about the books.
- A statistical summary of data in a base table. For example, you might define a view that contains only the average price of each type of book.
- A subset of another view, or of some combination of views and base tables.

Let's say you want to prevent some users from accessing the columns in the *titles* table that display money and sales amounts. You could create a view of the *titles* table that omits those columns, and then give all users permission on the view but only the Sales Department permission on the table:

```
grant all on bookview to public

grant all on titles to sales
```

An equivalent way of setting up these privilege conditions, without using a view, is to use the following statements:

```
grant all on titles to public

revoke select, update on titles (price, advance,
    total_sales)
from public

grant select, update on titles (price, advance,
    total_sales)
to sales
```

One possible problem with the second solution is that users not in the *sales* group who enter the command:

```
select * from titles
```

might be surprised to see the message that includes the phrase:

```
permission denied
```

Adaptive Server expands the asterisk into a list of all the columns in the *titles* table, and since permission on some of these columns has been revoked from non-sales users, access to these columns is denied. The error message lists the columns for which the user does not have access.

To see all the columns for which they do have permission, the non-sales users would have to name them explicitly. For this reason, creating a view and granting the appropriate permissions on it is a better solution.

You can also use views for **context-sensitive protection**. For example, you can create a view that gives a data entry clerk permission to access only those rows that he or she has added or updated. To do so, add a column to a table in which the user ID of the user entering each row is automatically recorded with a default. You can define this default in the **create table** statement, like this:

```
create table testtable
    (empid       int,
    startdate    datetime,
    username     varchar(30) default user)
```

Next, define a view that includes all the rows of the table where *uid* is the current user:

```
create view context_view
as
    select *
    from testtable
    where username = user_name()
with check option
```

The rows retrievable through this view depend on the identity of the person who issues the **select** command against the view. By adding **with check option** to the view definition, you make it impossible for any data entry clerk to falsify the information in the *username* column.

Using Stored Procedures As Security Mechanisms

If a stored procedure and all underlying objects are owned by the same user, that owner can grant users permission to use the procedure without granting permissions on the underlying objects. For example, you might give a user permission to execute a stored procedure that updates a row-and-column subset of a specified table, even though that user does not have any other permissions on that table.

Roles and Stored Procedures

Use the **grant execute** command to grant execute permission on a stored procedure to all users who have been granted a specified role. **revoke execute** removes this permission. But **grant execute** permission does not prevent users who do **not** have the specified role from being granted execute permission on the stored procedure.

For further security, you can restrict the use of a stored procedure by using the **proc_role** system function within the procedure to guarantee that a procedure can be executed only by users who have a given role. **proc_role** returns 1 if the user has a specific role (**sa_role**, **sso_role**, **oper_role**, or any user-defined role) and returns 0 if the user does not have that role. For example, here is a procedure that uses **proc_role** to see if the user has the System Administrator role:

```
create proc test_proc
as
if (proc_role("sa_role") = 0)
begin
    print "You don't have the right role"
    return -1
end
else
    print "You have SA role"
    return 0
```

See "System Functions" in the *Adaptive Server Reference Manual* for more information about **proc_role**.

Understanding Ownership Chains

Views can depend on other views and/or tables. Procedures can depend on other procedures, views, and/or tables. These dependencies can be thought of as an **ownership chain**.

Typically, the owner of a view also owns its underlying objects (other views and tables), and the owner of a stored procedure owns all the procedures, tables, and views referenced by the procedure.

A view and its underlying objects are usually all in the same database, as are a stored procedure and all the objects it references; however, this is not required. If objects are in different databases, a user wanting to use the view or stored procedure must be a valid user or guest user in all of the databases containing the objects. This prevents users from accessing a database unless the Database Owner has authorized it.

When a user who has been granted **execute** permission on a procedure or view uses it, Adaptive Server does not check permissions on any of the underlying objects if:

- These objects and the view or procedure are owned by the same user, and
- The user accessing the view or procedure is a valid user or guest user in each of the databases containing the underlying objects.

However, if all objects are not owned by the same user, Adaptive Server checks object permissions when the ownership chain is broken. That is, if object A references object B, and B is not owned by the user who owns object A, Adaptive Server checks the permissions for object B. In this way, Adaptive Server allows the owner of the original data to retain control over who is authorized to access it.

Ordinarily, a user who creates a view needs worry only about granting permissions on that view. For example, say Mary has created a view called *auview1* on the *authors* table, which she also owns. If Mary grants **select** permission to Sue on *auview1*, Adaptive Server will let Sue access it without checking permissions on *authors*.

However, a user who creates a view or stored procedure that depends on an object owned by another user must be aware that any permissions he or she grants depend on the permissions allowed by those other owners.

Example of Views and Ownership Chains

Say Joe creates a view called *auview2*, which depends on Mary's view *auview1*. Joe grants Sue **select** permission on *auview2*.

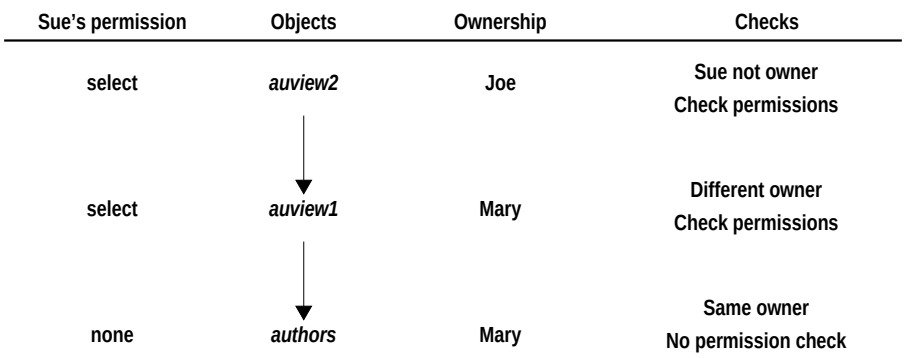

Figure 7-2: Ownership chains and permission checking for views, case 1

Adaptive Server checks the permissions on *auview2* and *auview1*, and finds that Sue can use them. Adaptive Server checks ownership on *auview1* and *authors* and finds that they have the same owner. Therefore, Sue can use *auview2*.

Taking this example a step further, suppose that Joe's view, *auview2*, depends on *auview1*, which depends on *authors*. Mary decides she likes Joe's *auview2* and creates *auview3* on top of it. Both *auview1* and *authors* are owned by Mary.

The ownership chain looks like this:

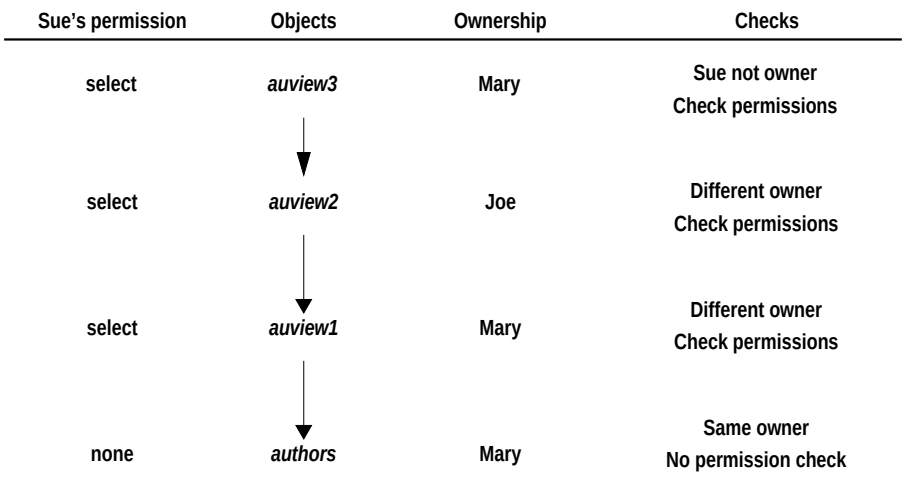

Figure 7-3: Ownership chains and permission checking for views, case 2

When Sue tries to access *auview3,* Adaptive Server checks permissions on *auview3, auview2,* and *auview1*. If Joe has granted permission to Sue on *auview2* and Mary has granted her permission on *auview3* and *auview1*, Adaptive Server allows the access. Adaptive Server checks permissions only if the object immediately before it in the chain has a different owner (or if it is the first object in the chain). For example, it checks *auview2* because the object before it—*auview3*—is owned by a different user. It does not check permission on *authors*, because the object that immediately depends on it, *auview1*, is owned by the same user.

Example of Procedures and Ownership Chains

Procedures follow the same rules as views. For example, suppose the ownership chain looks like this:

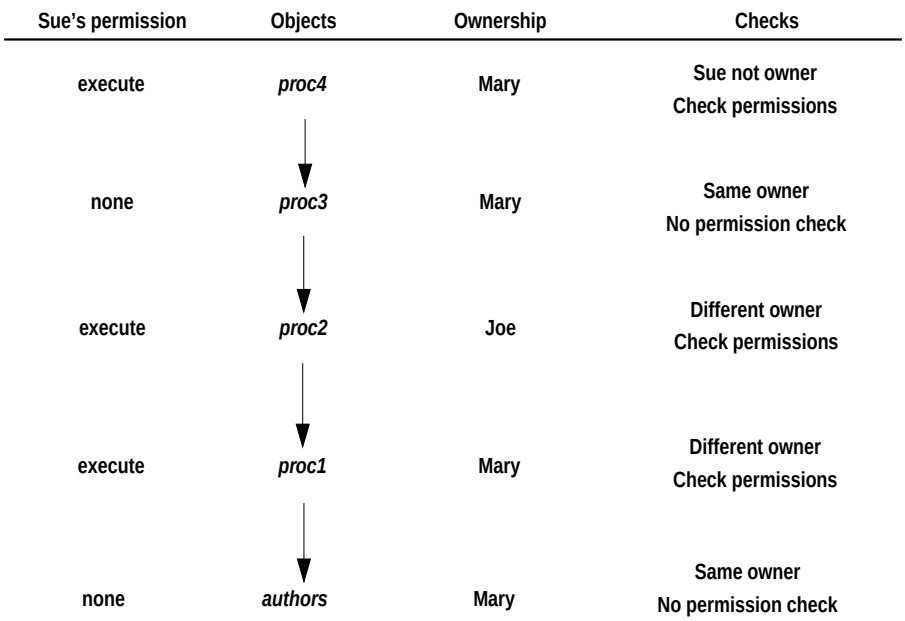

Figure 7-4: Ownership chains and permission checking for stored procedures

To execute **proc4**, Sue must have permission to execute **proc4**, **proc2**, and **proc1**. Permission to execute **proc3** is not necessary because **proc3** and **proc4** have the same owner.

Adaptive Server checks Sue's permissions on **proc4** and all objects it references each time she executes **proc4**. Adaptive Server knows which referenced objects to check: it determined this the first time Sue executed **proc4**, and it saved the information with the procedure's execution plan. Unless one of the objects referenced by the procedure is dropped or redefined, Adaptive Server does not change its initial decision about which objects to check.

This protection hierarchy allows every object's owner to fully control access to the object. Owners can control access to views and stored procedures, as well as to tables.

Permissions on Triggers

A **trigger** is a special kind of stored procedure used to enforce integrity, especially referential integrity. Triggers are never executed directly, but only as a side effect of modifying a table. You cannot **grant** or **revoke** permissions for triggers.

Only an object owner can create a trigger. However, the ownership chain can be broken if a trigger on a table references objects owned by different users. The protection hierarchy rules that apply to procedures also apply to triggers.

While the objects that a trigger affects are usually owned by the user who owns the trigger, you can write a trigger that modifies an object owned by another user. If this is the case, any users modifying your object in a way that activates the trigger must have permission on the other object as well.

If Adaptive Server denies permission on a data modification command because a trigger affects an object for which the user does not have permission, the entire data modification transaction is rolled back.

For more information on triggers, see the *Transact-SQL User's Guide* or the *Adaptive Server Reference Manual*.

8 Auditing

This chapter describes how to set up auditing for your installation. Topics include:

Introduction to Auditing in Adaptive Server

A principal element of a secure system is accountability. One way to ensure accountability is to audit events on the system. Many events that occur in Adaptive Server can be recorded.

Auditing is an important part of security in a database management system. An audit trail can be used to detect penetration of the system and misuse of resources. By examining the audit trail, a System Security Officer can inspect patterns of access to objects in databases and can monitor the activity of specific users. Audit records are traceable to specific users, which may act as a deterrent to users who are misusing the system.

Each audit record can log the nature of the event, the date and time, the user responsible for it, and the success or failure of the event. Among the events that can be audited are logins and logouts, server boots, use of data access commands, attempts to access particular objects, and a particular user's actions. The **audit trail**, or log of audit records, allows the System Security Officer to reconstruct events that have occurred on the system and evaluate their impact.

The System Security Officer is the only user who can start and stop auditing, set up auditing options, and process the audit data. As a System Security Officer, you can establish auditing for events such as:

- Server-wide, security-relevant events
- Creating, deleting, and modifying database objects
- All actions by a particular user or all actions by users with a particular role active
- Granting or revoking database access

- Importing or exporting data
- Logins and logouts

Correlating Adaptive Server and Operating System Audit Records

The easiest way to link Adaptive Server audit records with operating system records is to make Adaptive Server login names the same as operating system login names.

Alternatively, the System Security Officer can map users' operating system login names to their Adaptive Server login names. However, this approach requires ongoing maintenance, as login names for new users have to be recorded manually.

The Audit System

The audit system consists of:

- The *sybsecurity* database, which contains global auditing options and the audit trail
- The in-memory audit queue, to which audit records are sent before they are written to the audit trail
- Configuration parameters for managing auditing
- System procedures for managing auditing

The *sybsecurity* Database

The *sybsecurity* database is created during the auditing installation process. In addition to all the system tables found in the *model* database, it contains *sysauditoptions*, a system table for keeping track of server-wide auditing options, and system tables for the audit trail.

sysauditoptions contains the current setting of global auditing options, such as whether auditing is enabled for disk commands, remote procedure calls, ad hoc user-defined auditing records, or all security-relevant events. These options affect the entire Adaptive Server.

The Audit Trail

Adaptive Server stores the audit trail in system tables named *sysaudits_01* through *sysaudits_08*. When you install auditing, you determine the number of audit tables for your installation. For

example, if you choose to have two audit tables, they are named *sysaudits_01* and *sysaudits_02*. At any given time, only **one** audit table is **current**. Adaptive Server writes all audit data to the current audit table. A System Security Officer can use **sp_configure** to set, or change, which audit table is current.

The recommended number of tables is two or more with each table on a separate audit device. This allows you to set up a smoothly running auditing process in which audit tables are archived and processed with no loss of audit records and no manual intervention.

◆ ***WARNING!***

Sybase strongly recommends against using a single audit table on production systems. If you use only a single audit table, you may lose audit records. If you must use only a single audit table, because of limited system resources, refer to "Single-Table Auditing" on page 8-18 for instructions.

Figure 8-1 shows how the auditing process works with multiple audit tables.

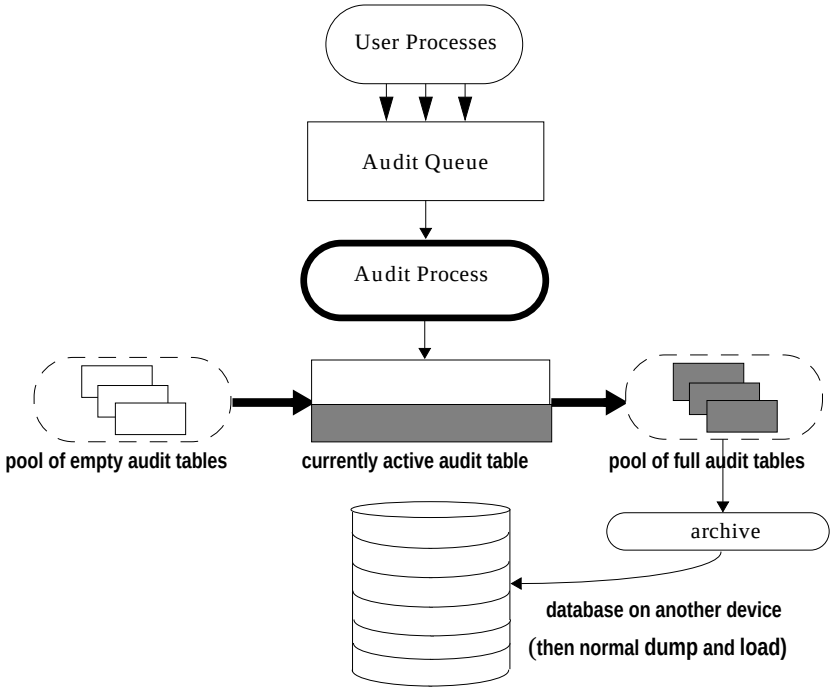

Figure 8-1: Auditing with multiple audit tables

The auditing system writes audit records from the in-memory audit queue to the current audit table. When the current audit table is nearly full, a threshold procedure can automatically archive the table to another database. The archive database, can be backed up and restored with the **dump** and **load** commands. For more information about managing the audit trail, see "Setting Up Audit Trail Management" on page 8-9.

The Audit Queue

When an audited event occurs, an audit record first goes to the in-memory audit queue. The record remains in memory until the audit process writes it to the audit trail. You can configure the size of the audit queue with the **audit queue size** parameter of **sp_configure**.

Before you configure the size of the audit queue, consider the trade-off between the risk of losing records in the queue if the system crashes and the loss of performance when the queue is full. As long as an audit record is in the queue, it can be lost if the system crashes. However, if the queue repeatedly becomes full, overall system performance is affected. If the audit queue is full when a user process tries to generate an audit record, the process sleeps until space in the queue becomes available.

➤ ***Note***

Because audit records are not written directly to the audit trail, you cannot count on an audit record's being stored immediately in the current audit table.

Auditing Configuration Parameters

Use these configuration parameters to manage the auditing process:

- **auditing** enables or disables auditing for the whole Adaptive Server. The parameter takes effect immediately upon execution of **sp_configure**. Auditing occurs only when this parameter is enabled.
- **audit queue size** establishes the size of the audit queue. Because the parameter affects memory allocation, the parameter does not take effect until Adaptive Server is restarted.
- **suspend audit when device full** controls the behavior of the audit process when an audit device becomes full. The parameter takes effect immediately upon execution of **sp_configure**.
- **current audit table** sets the current audit table. The parameter takes effect immediately upon execution of **sp_configure**.

System Procedures for Auditing

Use these system procedures to manage the auditing process:

- **sp_audit** enables and disables auditing options. This is the only system procedure required to establish the events to be audited.
- **sp_displayaudit** displays the active auditing options.
- **sp_addauditrecord** adds user-defined audit records (comments) into the audit trail. Users can add these records only if a System Security Officer enables ad hoc auditing with **sp_audit**.

Installing and Setting Up Auditing

Table 8-1 provides a general procedure for setting up auditing.

Table 8-1: General procedure for auditing

Action	Description	See
1. Install auditing.	Set the number of audit tables and assign devices for the audit trail and the *syslogs* transaction log in the *sybsecurity* database.	"Installing the Audit System" on page 8-6 and the Adaptive Server installation and configuration documentation
2. Set up audit trail management.	Write and establish a threshold procedure that receives control when the current audit table is nearly full. The procedure automatically switches to a new audit table and archives the contents of the current table. In addition, this step involves setting the **audit queue size** and the **suspend audit when device full** configuration parameters.	"Setting Up Audit Trail Management" on page 8-9 For single-table auditing, "Single-Table Auditing" on page 8-18
3. Set up transaction log management in the *sybsecurity* database.	Determine how to handle the *syslogs* transaction log in the *sybsecurity* database, how to set the **trunc log on chkpt** database option and establishing a last-chance threshold procedure for *syslogs* if **trunc log on chkpt** is off.	"Setting Up Transaction Log Management" on page 8-16
4. Set auditing options.	Using **sp_audit** to establish the events to be audited.	"Setting Global Auditing Options" on page 8-23
5. Enable auditing.	Using **sp_configure** to turn on the **auditing** configuration parameter. Adaptive Server begins writing audit records to the current audit table.	"Enabling and Disabling Auditing" on page 8-18.

Installing the Audit System

The audit system is usually installed with **auditinit**, the Sybase installation program. Alternatively, you can install auditing without **auditinit**. For details, see "Installing Auditing with installsecurity" on page 8-7. Installation and **auditinit** are discussed in the Adaptive Server installation and configuration documentation for your platform.

When you install auditing, you can establish the number of system tables you want to use for the audit trail, the device for each audit system table, and the device for the *syslogs* transaction log.

Tables and Devices for the Audit Trail

You can specify up to eight system tables (*sysaudits_01* through *sysaudits_08*). Plan to use at least two tables for the audit trail. Put each table on its own device separate from the master device. If you do this, you can use a threshold procedure to automatically archive the current audit table before it fills up and switch to a new empty table for the subsequent audit records.

Device for the *syslogs* Transaction Log Table

When you install auditing, you must specify a separate device for the transaction log, which consists of the *syslogs* system table. The *syslogs* table, which exists in every database, contains a log of the transactions that are executed in the database.

Installing Auditing with *installsecurity*

The *$SYBASE/scripts* directory contains **installsecurity**, a script for installing auditing.

To use **installsecurity** to install auditing:

1. Create the auditing devices and auditing database with the Transact-SQL **disk init** and **create database** commands. For example:

```
disk init name = "auditdev",
    physname = "/dev/dsk/c2d0s4",
    vdevno = 3, size = 5120

disk init name = "auditlogdev",
    physname = "/dev/dsk/c2d0s5",
    vdevno = 4, size = 1024

create database sybsecurity on auditdev
    log on auditlogdev
```

2. Use **isql** to execute the **installsecurity** script:

```
cd $SYBASE/scripts
setenv DSQUERY server_name
isql -Usa -Ppassword -Sserver_name < installsecurity
```

3. Shut down and restart Adaptive Server.

When you have completed these steps, the *sybsecurity* database has one audit table (*sysaudits_01*) created on its own segment. You can enable auditing at this time, but should add more auditing tables with **sp_addaudittable**. For information about **disk init**, **create database**, and **sp_addaudittable**, see the *Adaptive Server Reference Manual*.

Moving the Auditing Database to Multiple Devices

Place the *sybsecurity* database on its own device, separate from the *master* database. If you have more than one audit table, place each table on its own device. If you currently have *sybsecurity* on the same device as *master*, or if you want to move *sybsecurity* to another device, use one of the procedures described in the following sections. When you move the database, you can specify whether to save your existing global audit settings.

Moving sybsecurity Without Saving Global Audit Settings

To move the *sybsecurity* database without saving the global audit settings:

1. Drop the *sybsecurity* database.
2. Install *sybsecurity* again using the installation procedure described in either:
   - The the configuration documentation for your platform
   - "Installing Auditing with installsecurity" on page 8-7.
3. During the installation process, be sure to place the *sybsecurity* database on one or more devices, separate from the master device.

Moving sybsecurity and Saving Global Audit Settings

To move the *sybsecurity* database and save the global audit settings:

1. Dump the *sybsecurity* database.

   ```
   dump database sybsecurity to "/remote/sec_file"
   ```

2. Drop the *sybsecurity* database.

   ```
   drop database sybsecurity
   ```

3. Initialize the first device on which you want to place the *sybsecurity* database.

```
disk init name = "auditdev",
    physname = "/dev/dsk/c2d0s4",
    vdevno = 3, size = 5120
```

4. Initialize the device where you want to place the security log.

   ```
   disk init name = "auditlogdev",
       physname = "/dev/dsk/c2d0s5",
       vdevno = 4, size = 1024
   ```

5. Create the new *sybsecurity* database.

   ```
   create database sybsecurity on auditdev
       log on auditlogdev
   ```

6. Load the contents of the old *sybsecurity* database into the new database. The global audit settings are preserved.

   ```
   load database sybsecurity from "/remote/sec_file"
   ```

7. Run **online database**, which will upgrade *sysaudits* and *sysauditoptions* if necessary.

   ```
   online database sybsecurity
   ```

8. Load the auditing system procedures using the configuration documentation for your platform.

To create more than one *sysaudits* table in *sybsecurity*:

1. Initialize the device where you want to place the additional table.

   ```
   disk init name = "auditdev2",
       physname = "/dev/dsk/c2d0s6",
       vdevno = 3, size = 5120
   ```

2. Extend the *sybsecurity* database to the device you initialized in step 1.

   ```
   alter database sybsecurity on auditdev2 = 2
   ```

3. Run **sp_addaudittable** to create the next *sysaudits* table on the device you initialized in step 1.

   ```
   sp_addaudittable auditdev2
   ```

4. Repeat steps 1–3 for each *sysaudits* table.

Setting Up Audit Trail Management

To effectively manage the audit trail:

1. Be sure that auditing is installed with two or more tables, each on a separate device. If not, consider adding additional audit tables and devices.
2. Write a threshold procedure and attach it to each audit table segment.
3. Set configuration parameters for the audit queue size and to indicate appropriate action should the current audit table become full.

The following sections assume that you have installed auditing with two or more tables, each on a separate device. If you have only one device for the audit tables, skip to "Single-Table Auditing" on page 8-18.

Setting Up Threshold Procedures

Before enabling auditing, establish a threshold procedure to automatically switch auditing tables when the current table is full.

The threshold procedure for the audit device segments should:

- Make the next empty audit table current using **sp_configure.**
- Archive the audit table that is almost full using the **insert** and **select** commands.

Changing the Current Audit Table

The **current audit table** configuration parameter establishes the table where Adaptive Server writes audit rows. As a System Security Officer, you can change the current audit table with **sp_configure**, using the following syntax:

```
sp_configure "current audit table", n
  [, "with truncate"]
```

where *n* is an integer that determines the new current audit table. The valid values for *n* are:

- 1 means *sysaudits_01*, 2 means *sysaudits_02*, and so forth.
- 0 tells Adaptive Server to automatically set the current audit table to the next table. For example, if your installation has three audit tables, *sysaudits_01*, *sysaudits_02*, and *sysaudits_03*, Adaptive Server sets the current audit table to:
  - 2 if the current audit table is *sysaudits_01*
  - 3 if the current audit table is *sysaudits_02*

- 1 if the current audit table is *sysaudits_03*

The **with truncate** option specifies that Adaptive Server should truncate the new table if it is not already empty. If you do not specify this option and the table is not empty, **sp_configure** fails.

➤ ***Note***

If Adaptive Server truncates the current audit table and you have not archived the data, the table's audit records are lost. Archive the audit data before you use the **with truncate** option.

To execute **sp_configure** to change the current audit table, you must have the **sso_role** active. You can write a threshold procedure to automatically change the current audit table.

Archiving the Audit Table

You can use **insert** with **select** to copy the audit data into an existing table having the same columns as the audit tables in *sybsecurity*.

Be sure that the threshold procedure can successfully copy data into the archive table in another database:

1. Create the archive database on a separate device from the one containing audit tables in *sybsecurity*.
2. Create an archive table with columns identical to those in the *sybsecurity* audit tables. If such a table does not already exist, you can use **select into** to create an empty one by having a false condition in the **where** clause. For example:

   ```
   use aud_db
   go
   select *
     into audit_data
     from sybsecurity.dbo.sysaudits_01
     where 1 = 2
   ```

   The **where** condition is always false, so an empty duplicate of *sysaudits_01* is created.

   The **select into/bulk copy** database option must be turned on in the archive database (using **sp_dboption**) before you can use **select into**.

The threshold procedure, after using **sp_configure** to change the audit table, can use **insert** and **select** to copy data to the archive table in the archive database. The procedure can execute commands similar to these:

```
   insert aud_db.sso_user.audit_data
   select * from sybsecurity.dbo.sysaudits_01
```

Example Threshold Procedure for Audit Segments

This sample threshold procedure assumes that three tables are configured for auditing:

```
declare @audit_table_number int
/*
** Select the value of the current audit table
*/
select @audit_table_number = value
     from master.dbo.sysconfigures
     where name = "current audit table"
/*
** Set the next audit table to be current.
** When the next audit table is specified as 0,
** the value is automatically set to the next one.
*/
sp_configure "current audit table", 0, "with truncate"
/*
** Copy the audit records from the audit table
** that became full into another table.
*/
if @audit_table_number = 1
     insert aud_db.sso_user.audit_data
          select * from sysaudit_01
     truncate table sysaudit_01
else if @audit_table_number = 2
     insert aud_db.sso_user.audit_data
          select * from sysaudit_02
     truncate table sysaudit_02
else if @audit_table_number = 3
     insert aud_db.sso_user.audit_data
          select * from sysaudit_03
     truncate table sysaudit_03
return(0)
```

Attaching the Threshold Procedure to Each Audit Segment

To attach the threshold procedure to each audit table segment, use the **sp_addthreshold**.

Before executing **sp_addthreshold**:

- Determine the number of audit tables configured for your installation and the names of their device segments

- Have the permissions and roles you need for **sp_addthreshold** for all the commands in the threshold procedure

◆ ***WARNING!***

sp_addthreshold and sp_modifythreshold check to ensure that only a user with sa_role directly granted can add or modify a threshold. All system-defined roles that are active when you add or modify a threshold are inserted as valid roles for your login in the *systhresholds* table. However, only directly granted roles are activated when the threshold procedure fires.

Audit Tables and Their Segments

When you install auditing, **auditinit** displays the name of each audit table and its segment. The segment names are "aud_seg1" for *sysaudits_01*, "aud_seg2" for *sysaudits_02*, and so forth. You can find information about the segments in the *sybsecurity* database if you execute **sp_helpsegment** with *sybsecurity* as your current database. One way to find the number of audit tables for your installation is to execute the following SQL commands:

```
use sybsecurity
go
select count(*) from sysobjects
  where name like "sysaudit%"
go
```

In addition, you can get information about the audit tables and the *sybsecurity* database by executing the following SQL commands:

```
sp_helpdb sybsecurity
go
use sybsecurity
go
sp_help sysaudits_01
go
sp_help sysaudits_02
go
  ...
```

Required Roles and Permissions

To execute **sp_addthreshold**, you must be either the Database Owner or a System Administrator. A System Security Officer should be the owner of the *sybsecurity* database and, therefore, should be able to

execute **sp_addthreshold**. In addition to being able to execute **sp_addthreshold**, you must have permission to execute all the commands in your threshold procedure. For example, to execute **sp_configure** for **current audit table**, the **sso_role** must be active. When the threshold procedure fires, Adaptive Server attempts to turn on all the roles and permissions that were in effect when you executed **sp_addthreshold**.

To attach the threshold procedure **audit_thresh** to three device segments:

```
use sybsecurity
go
sp_addthreshold sybsecurity, aud_seg1, 250,
    audit_thresh
sp_addthreshold sybsecurity, aud_seg2, 250,
    audit_thresh
sp_addthreshold sybsecurity, aud_seg3, 250,
    audit_thresh
go
```

The sample threshold procedure **audit_thresh** receives control when fewer than 250 free pages remain in the current audit table.

For more information about adding threshold procedures, see Chapter 29, “Managing Free Space with Thresholds.”

Auditing with the Sample Threshold Procedure in Place

After you enable auditing, Adaptive Server writes all audit data to the initial current audit table, *sysaudits_01*. When *sysaudits_01* is within 250 pages of being full, the threshold procedure **audit_thresh** fires. The procedure switches the current audit table to *sysaudits_02*, and, immediately, Adaptive Server starts writing new audit records to *sysaudits_02*. The procedure also copies all audit data from *sysaudits_01* to the *audit_data* archive table in the *audit_db* database. The rotation of the audit tables continues in this fashion without manual intervention.

Setting Auditing Configuration Parameters

Set the following configuration parameters for your auditing installation:

- **audit queue size** sets the number of records in the audit queue in memory.

- **suspend audit when device full** determines what Adaptive Server does if the current audit table becomes completely full. The full condition occurs only if the threshold procedure attached to the current table segment is not functioning properly.

Setting the Size of the Audit Queue

The memory requirement for a single audit record is 424 bytes. The default size for the audit queue is 100 records, which requires approximately 42K.

To set the size of the audit queue, use **sp_configure**. The syntax is:

```
sp_configure "audit queue size", [value]
```

value is the number of records that the audit queue can hold. The minimum value is 1, and the maximum is 65,535. For example, to set the audit queue size to 300, execute:

```
sp_configure "audit queue size", 300
```

For more information about setting the audit queue size and other configuration parameters, see Chapter 17, "Setting Configuration Parameters."

Suspending Auditing if Devices are Full

If you have two or more audit tables, each on a separate device other than the master device, and have a threshold procedure for each audit table segment, the audit devices should never become full. Only if a threshold procedure is not functioning properly would the "full" condition occur. You can use **sp_configure** to set the **suspend audit when device full** parameter to determine what happens if the devices do become full. Choose one of these options:

- Suspend the auditing process and all user processes that cause an auditable event. Resume normal operation after a System Security Officer clears the current audit table.
- Truncate the next audit table and start using it. This allows normal operation to proceed without intervention from a System Security Officer.

To set this configuration parameter, use **sp_configure**. You must have the **sso_role** active. The syntax is:

```
sp_configure "suspend audit when device full",
    [0|1]
```

0 truncates the next audit table and starts using it as the current audit table whenever the current audit table becomes full. If you set the

parameter to 0, the audit process is never suspended; however, older audit records will be lost if they have not been archived.

1 (the default value) suspends the audit process and all user processes that cause an auditable event. To resume normal operation, the System Security Officer must log in and set up an empty table as the current audit table. During this period, the System Security Officer is exempt from normal auditing. If the System Security Officer's actions would generate audit records under normal operation, Adaptive Server sends an error message and information about the event to the error log.

If you have a threshold procedure attached to the audit table segments, set **suspend audit when device full** to **1** (on). If it is set to **0** (off), Adaptive Server may truncate the audit table that is full before your threshold procedure has a chance to archive your audit records.

Setting Up Transaction Log Management

This section describes guidelines for managing the transaction log in *sybsecurity*.

If the **trunc log on chkpt** database option is active, Adaptive Server truncates *syslogs* every time it performs an automatic **checkpoint**. After auditing is installed, the value of **trunc log on chkpt** is **on**, but you can use **sp_dboption** to change its value.

Truncating the Transaction Log

If you enable the **trunc log on chkpt** option for the *sybsecurity* database, you do not need to worry about the transaction log becoming full. Adaptive Server truncates the log whenever it performs a checkpoint. With this option on, you cannot use **dump transaction** to dump the transaction log, but you can use **dump database** to dump the database.

If you follow the procedures in "Setting Up Threshold Procedures" on page 8-10, audit tables are automatically archived to tables in another database. You can use standard backup and recovery procedures for this archive database.

If a crash occurs on the *sybsecurity* device, you can reload the database and resume auditing. At most, only the records in the in-memory audit queue and the current audit table are lost because the archive database contains all other audit data. After you reload the

database, use **sp_configure with truncate** to set and truncate the current audit table.

If you have not changed server-wide auditing options since you dumped the database, all auditing options stored in *sysauditoptions* are automatically restored when you reload *sybsecurity*. If not, you can run a script to set the options prior to resuming auditing.

Managing the Transaction Log With No Truncation

If you use **db_option** to turn the **trunc log on chkpt** off, the transaction log may fill up. Plan to attach a **last-chance threshold procedure** to the transaction log segment. This procedure gets control when the amount of space remaining on the segment is less than a threshold amount computed automatically by Adaptive Server. The threshold amount is an estimate of the number of free log pages that would be required to back up the transaction log.

The default name of the last-chance threshold procedure is **sp_thresholdaction**, but you can specify a different name with **sp_modifythreshold**, as long as you have the **sa_role** active.

➤ ***Note***

sp_modifythreshold checks to ensure you have "sa_role" active. See "Attaching the Threshold Procedure to Each Audit Segment" on page 8-12 for more information.

Adaptive Server does not supply a default procedure, but Chapter 29, "Managing Free Space with Thresholds" contains examples of last-chance threshold procedures. The procedure should execute the **dump transaction** command, which truncates the log. When the transaction log reaches the last-chance threshold point, any transaction that is running is suspended until space is available. The suspension occurs because the option **abort xact when log is full** is always set to FALSE for the *sybsecurity* database. You cannot change this option.

With the **trunc log on chkpt** option off, you can use standard backup and recovery procedures for the *sybsecurity* database, but be aware that the audit tables in the restored database may not be in sync with their status at the time of a device failure.

Enabling and Disabling Auditing

To enable or disable auditing, use **sp_configure** with the **auditing** configuration parameter. The syntax is:

```
sp_configure "auditing", [0 | 1 ]
```

1 enables auditing. **0** disables auditing. For example, to enable auditing, enter:

```
sp_configure "auditing", 1
```

➤ *Note*

When you enable or disable auditing, Adaptive Server automatically generates an audit record. See event codes 73 and 74 in Table 8-6 on page 8-34.

Single-Table Auditing

Sybase strongly recommends that you **not** use single-device auditing for production systems. If you use only a single audit table, you create a window of time while you are archiving audit data and truncating the audit table during which incoming audit records will be lost. There is no way to avoid this when using only a single audit table.

If you use only a single audit table, your audit table is likely to fill up. The consequences of this depend on how you have set **suspend audit when device full**. If you have **suspend audit when device full** set to on, the audit process is suspended, as are all user processes that cause auditable events. If **suspend audit when device full** is off, the audit table is truncated, and you lose all the audit records that were in the audit table.

For **non-production** systems, where the loss of a small number of audit records may be acceptable, you can use a single table for auditing, if you cannot spare the additional disk space for multiple audit tables, or you do not have additional devices to use.

The procedure for using a single audit table is similar to using multiple audit tables, with these exceptions:

- During installation, you specify only one system table to use for auditing.
- During installation, you specify only one device for the audit system table.

- The threshold procedure you create for archiving audit records is different from the one you would create if you were using multiple audit tables.

Figure 8-2 shows how the auditing process works with a single audit table.

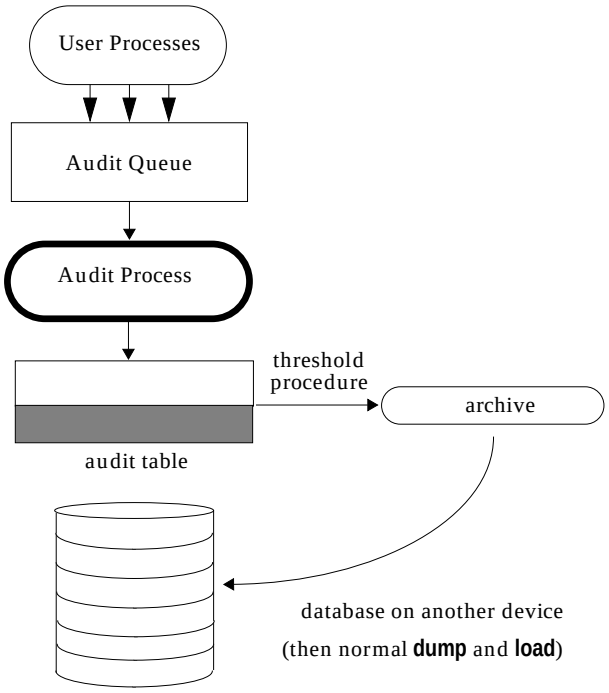

Figure 8-2: Auditing with a single audit table

Establishing and Managing Single-Table Auditing

Table 8-2 provides an overview of managing single-table auditing.

Table 8-2: Auditing process for single-table auditing

Action	Description	See
1. Install auditing.	Installation of auditing, which involves setting the number of audit tables and assigning devices for the audit trail and the *syslogs* transaction log in the *sybsecurity* database.	The the installation documentation for your platform
2. Set up the audit process to manage the audit trail.	Writing and establishing a threshold procedure that receives control when the audit table is nearly full. The procedure automatically writes the contents of the audit table to another table, and then truncates the audit table. In addition, this step involves setting the **audit queue size** and **suspend audit when device full** configuration parameters.	"Establishing and Managing Single-Table Auditing" on page 8-20. "Threshold Procedure for Single-Table Auditing" on page 8-21.
3. Set up the audit process to manage the *syslogs* transaction log in the *sybsecurity* database.	Determining how to handle the *syslogs* transaction log in the *sybsecurity* database. The task includes determining the setting of the **trunc log on chkpt** database option and establishing a last-chance threshold procedure for *syslogs* if **trunc log on chkpt** is off.	"Setting Up Transaction Log Management" on page 8-16.
4. Set auditing options.	Using **sp_audit** to establish the events to be audited. **Note:** No audit records are generated until auditing is turned on with **sp_configure**.	"Setting Global Auditing Options" on page 8-23
5. Enable auditing.	Using **sp_configure** to turn on the **auditing** configuration parameter. Adaptive Server begins writing audit records for audited events to the current audit table.	"Enabling and Disabling Auditing" on page 8-18

Threshold Procedure for Single-Table Auditing

For single-table auditing, the threshold procedure should:

- Archive the almost-full audit table to another table, using the **insert** and **select** commands.
- Truncate the audit table to create space for new audit records, using the **truncate table** command.

Before you can archive your audit records, create an archive table that has the same columns as your audit table. After you have done this, your threshold procedure can use **insert** with **select** to copy the audit records into the archive table.

Here is a sample threshold procedure for use with a single audit table:

```
create procedure audit_thresh as
/*
** copy the audit records from the audit table to
** the archive table
*/
insert aud_db.sso_user.audit_data
    select * from sysaudits_01
return(0)
go
/*
** truncate the audit table to make room for new
** audit records
*/
truncate table "sysaudits_01"
go
```

After you have created your threshold procedure, you will need to attach the procedure to the audit table segment. For instructions, see "Attaching the Threshold Procedure to Each Audit Segment" on page 8-12.

◆ ***WARNING!***

On a multiprocessor, the audit table may fill up even if you have a threshold procedure that triggers before the audit table is full. For example, if the threshold procedure is running on a heavily loaded CPU, and a user process performing auditable events is running on a less heavily loaded CPU, it is possible that the audit table can fill up before the threshold procedure triggers. The configuration parameter suspend audit when device full determines what happens when the audit table fills up. For information about setting this parameter, see "Suspending Auditing if Devices are Full" on page 8-15.

What Happens When the Current Audit Table Is Full?

When the current audit table is full:

1. The audit process attempts to insert the next audit record into the table. This fails, so the audit process terminates. An error message goes to the error log.
2. When a user attempts to perform an auditable event, the event cannot be completed because auditing cannot proceed. The user process terminates. Users who do not attempt to perform an auditable event are unaffected.
3. If you have login auditing enabled, no one can log in to the server except a System Security Officer.
4. If you are auditing commands executed with the **sso_role** active, the System Security Officer will be unable to execute commands.

Recovering When the Current Audit Table Is Full

If the current audit device and the audit queue becomes full, the System Security Officer becomes exempt from auditing. Every auditable event performed by a System Security Officer after this point sends a warning message to the error log file. The message states the date and time and a warning that an audit has been missed, as well as the login name, *event* code, and other information that would normally be stored in the *extrainfo* column of the audit table.

When the current audit table is full, the System Security Officer can archive and truncate the audit table as described in "Archiving the Audit Table" on page 8-11. A System Administrator can execute

shutdown to stop the server and then restart the server to reestablish auditing.

If the audit system terminates abnormally, the System Security Officer can shut down the server after the current audit table has been archived and truncated. Normally, only the System Administrator can execute **shutdown**.

Setting Global Auditing Options

After you have installed auditing, you can use **sp_audit** to set auditing options. The syntax for **sp_audit** is:

```
sp_audit option, login_name, object_name [,setting]
```

If you run **sp_audit** with no parameters, it provides a complete list of the options. For details about **sp_audit**, see the *Adaptive Server Reference Manual*.

➤ ***Note***

No auditing occurs until you activate auditing for the server. For information on how to start auditing, see “Enabling and Disabling Auditing” on page 8-18.

Auditing Options: Their Types and Requirements

The values you can specify for the *login_name* and *object_name* parameters to **sp_audit** depend on the type of auditing option you specify:

- Global options apply to commands that affect the entire server, such as booting the server, disk commands, and allowing ad hoc, user-defined audit records. Option settings for global events are stored in the *sybsecurity..sysauditoptions* system table.
- Database-specific options apply to a database. Examples include altering a database, bulk copy (**bcp in**) of data into a database, granting or revoking access to objects in a database, and creating objects in a database. Option settings for database-specific events are stored in the *master..sysdatabases* system table.
- Object-specific options apply to a specific object. Examples include selecting, inserting, updating, or deleting rows of a particular table or view and the execution of a particular trigger

or procedure. Option settings for object-specific events are stored in the *sysobjects* system table in the relevant database.

- User-specific options apply to a specific user or system role. Examples include accesses by a particular user to any table or view or all actions performed when a particular system role, such as **sa_role**, is active. Option settings for individual users are stored in *master..syslogins*. The settings for system roles are stored in *master..sysauditoptions*.

Table 8-3 shows:

- Valid values for the *option* and the type of each option – global, database-specific, object-specific, or user-specific
- Valid values for the *login_name* and *object_name* parameters for each option
- The database to be in when you set the auditing option
- The command or access that is audited when you set the option
- An example for each option

The default value of all options is off.

Table 8-3: Auditing options, requirements, and examples

Option (Option Type)	*login_name*	*object_name*	Database to Be In To Set the Option	Command or Access Being Audited
adhoc (user-specific)	**all**	**all**	Any	Allows users to use **sp_addauditrecord**
Example:	`sp_audit "adhoc", "all", "all", "on"` (Enables ad hoc user-defined auditing records.)			
all (user-specific)	A login name or role	**all**	Any	All actions of a particular user or by users with a particular role active
Example	`sp_audit "all", "sa_role", "all", "on"` (Turns auditing on for all actions in which the **sa_role** is active.)			
alter (database-specific)	**all**	Database to be audited	Any	**alter database**, **alter table**
Example	`sp_audit @option = "alter", @login_name = "all", @object_name = "master", @setting = "on"` (Turns auditing on for all executions of **alter database** and **alter table** in the *master* database.)			

Table 8-3: Auditing options, requirements, and examples (continued)

Option (Option Type)	*login_name*	*object_name*	Database to Be In To Set the Option	Command or Access Being Audited
bcp (database-specific)	**all**	Database to be audited	Any	**bcp in**
Example	`sp_audit "bcp", "all", "pubs2"` (Returns the status of **bcp** auditing in the *pubs2* database. If you do not specify a value for *setting*, Adaptive Server returns the status of auditing for the option you specify)			
bind (database-specific)	**all**	Database to be audited	Any	**sp_bindefault**, **sp_bindmsg**, **sp_bindrule**
Example	`sp_audit "bind", "all", "planning", "off"` (Turns bind auditing off for the *planning* database.)			
cmdtext (user-specific)	A login name or a role	**all**	Any	All actions of a particular user or by users with a particular role active
Example	`sp_audit "cmdtext", "dbo", "off"` (Turns text auditing off for Database Owners.)			
create (database-specific)	**all**	Database to be audited Specify *master* for *object_name* if you want to audit **create database**. You will also be auditing the creation of other objects in *master*.	Any	**create database**, **create table**, **create procedure**, **create trigger**, **create rule**, **create default**, **sp_addmessage**, **create view**
Example:	`sp_audit "create", "all", "planning", "pass"` (Turns on auditing of successful object creations in the *planning* database. The current status of auditing **create database** is not affected because you did not specify the *master* database.)			
dbaccess (database-specific)	**all**	Database to be audited	Any	Any access to the database from another database
Example:	`sp_audit "dbaccess", "all", "project", "on"` (Audits all external accesses to the *project* database.)			
dbcc (global)	**all**	**all**	Any	**dbcc**

Table 8-3: Auditing options, requirements, and examples (continued)

Option (Option Type)	*login_name*	*object_name*	Database to Be In To Set the Option	Command or Access Being Audited
Example:	`sp_audit "dbcc", "all", "all", "on"`			
	(Audits all executions of the **dbcc** command.)			
delete (object-specific)	**all**	Table or view, **default table**, or **default view**	The database of the table or view (except *tempdb*)	**delete** from a table, **delete** from a view
Example:	`sp_audit "delete", "all", "default table", "on"`			
	(Audits all delete actions for all future tables in the current database.)			
disk (global)	**all**	**all**	Any	**disk init, disk refit, disk reinit, disk mirror, disk unmirror, disk remirror**
Example:	`sp_audit "disk", "all", "all", "on"`			
	(Audits all disk actions for the server.)			
drop (database-specific)	**all**	Database to be audited	Any	**drop database**, **drop table**, **drop procedure**, **drop trigger**, **drop rule**, **drop default**, **sp_dropmessage**, **drop view**
Example:	`sp_audit "drop", "all", "financial", "fail"`			
	(Audits all drop commands in the *financial* database that fail permission checks.)			
dump (database-specific)	**all**	Database to be audited	Any	**dump database**, **dump transaction**
Example:	`sp_audit "dump", "all", "pubs2", "on"`			
	(Audits dump commands in the *pubs2* database.)			
errors (global)	**all**	**all**	Any	Fatal error, non-fatal error
Example:	`sp_audit "errors", "all", "all", "on"`			
	(Audits errors throughout the server.)			
exec_procedure (object-specific)	**all**	Procedure or **default procedure**	The database of the procedure (except *tempdb*)	**execute**
Example:	`sp_audit "exec_procedure", "all", "default procedure", "off"`			
	(Turns automatic auditing off of new procedures in the current database.)			

Table 8-3: Auditing options, requirements, and examples (continued)

Option (Option Type)	*login_name*	*object_name*	Database to Be In To Set the Option	Command or Access Being Audited
exec_trigger (object-specific)	**all**	Trigger or **default trigger**	The database of the trigger (except *tempdb*)	Any command that fires the trigger
Example:	`sp_audit "exec_trigger", "all", "trig_fix_plan", "fail"` (Audits all failed executions of the **trig_fix_plan** trigger in the current database.)			
func_dbaccess (database-specific)	**all**	Database	Any	Access to the database via Transact-SQL built-in functions
Example:	`sp_audit @option="func_dbaccess", @login_name="all", @object_name = "strategy", @setting = "on"` (Audits accesses to the *strategy* database via built-in functions.)			
func_obj_access (object-specific)	**all**	Object	Any	Access to an object via Transact-SQL built-in functions
Example:	`sp_audit @option="func_obj_access", @login_name="all", @object_name = "customer", @setting = "on"` (Audits accesses to the *customer* table via built-in functions.)			
grant (database-specific)	**all**	Database to be audited	Any	**grant**
Example:	`sp_audit @option="grant", @login_name="all", @object_name = "planning", @setting = "on"` (Audits all grants in the *planning* database.)			
insert (object-specific)	**all**	Table or view, **default table**, or **default view**	The database of the object (except *tempdb*)	**insert** into a table, **insert** into a view
Example:	`sp_audit "insert", "all", "dpt_101_view", "on"` (Audits all inserts into the *dpt_101_view* view in the current database..)			
load (database-specific)	**all**	Database to be audited	Any	**load database**, **load transaction**
Example:	`sp_audit "load", "all", "projects_db", "fail"` (Audits all failed executions of database and transaction loads in the *projects_db* database.)			

Table 8-3: Auditing options, requirements, and examples (continued)

Option (Option Type)	*login_name*	*object_name*	Database to Be In To Set the Option	Command or Access Being Audited
login (global)	**all**	**all**	Any	Any login to Adaptive Server
Example:	`sp_audit "login", "all", "all", "fail"` (Audits all failed attempts to log in to the server.)			
logout (global)	**all**	**all**	Any	Any logout from Adaptive Server
Example:	`sp_audit "logout", "all", "all", "off"` (Turns auditing off of logouts from the server.)			
reference (object-specific)	**all**	Table to be audited	Any	Creation of a reference between tables
Example:	`sp_audit "reference", "all", "titles", "off"` (Turns off auditing of the creation of references between the *titles* table and other tables.)			
revoke (database-specific)	**all**	Database to be audited	Any	**revoke**
Example:	`sp_audit "revoke", "all", "payments_db", "off"` (Turns off auditing of the execution of **revoke** in the *payments_db* database.)			
rpc (global)	**all**	**all**	Any	Remote procedure calls (either in or out)
Example:	`sp_audit "rpc", "all", "all", "on"` (Audits all remote procedure calls out of or into the server.)			
security (global)	**all**	**all**	Any	Server-wide security-relevant events. See the “security” option in Table 8-3.
Example:	`sp_audit "security", "all", "all", "on"` (Audits server-wide security-relevant events in the server.)			
select (object-specific)	**all**	Table or view, **default table**, or **default view**	The database of the object (except *tempdb*)	**select** from a table, **select** from a view
Example:	`sp_audit "select", "all", "customer", "fail"` (Audits all failed selects from the *customer* table in the current database.)			
setuser (database-specific)	**all**	**all**	Any	**setuser**

Table 8-3: Auditing options, requirements, and examples (continued)

Option (Option Type)	*login_name*	*object_name*	Database to Be In To Set the Option	Command or Access Being Audited
Example:	`sp_audit "setuser", "all", "projdb", "on"` (Audits all executions of **setuser** in the *projdb* database.)			
table_access (user-specific)	Login name	**all**	Any	**select**, **delete**, **update**, or **insert** access in a table
Example:	`sp_audit "table_access", "smithson", "all", "on"` (Audits all table accesses by the login named "smithson".)			
truncate (database-specific)	**all**	Database to be audited	Any	**truncate table**
Example:	`sp_audit "truncate", "all", "customer", "on"` (Audits all table truncations in the *customer* database.)			
unbind (database-specific)	**all**	Database to be audited	Any	**sp_unbindefault**, **sp_unbindrule**, **sp_unbindmsg**
Example:	`sp_audit "unbind", "all", "master", "fail"` (Audits all failed attempts of unbinding in the *master* database.)			
update (object-specific)	**all**	View, **default table**, or **default view**	The database of the object (except *tempdb*)	**update** to a table, **update** to a view
Example:	`sp_audit "update", "all", "projects", "on"` (Audits all attempts by users to update the *projects* table in the current database.)			
view_access (user-specific)	Login name	**all**	Any	**select**, **delete**, **insert**, or **update** to a view
Example:	`sp_audit "view_access", "joe", "all", "off"` (Turns off view auditing of user "joe".)			

Examples of Setting Auditing Options

Suppose you want to audit all failed deletions on the *projects* table in the *company_operations* database and for all new tables in the database. Use the object-specific **delete** option for the *projects* table and use **default table** for all future tables in the database. To set object-specific auditing options, you must be in the object's database before you execute **sp_audit**:

```
sp_audit “security”, “all”, “all”, “fail”
```

- For this example, execute:

```
use company_operations
go
sp_audit "delete", "all", "projects", "fail"
go
sp_audit "delete", "all", "default table",
"fail"
go
```

Determining Current Auditing Settings

To determine the current auditing settings for a given option, use **sp_displayaudit**. The syntax is:

```
sp_displayaudit [procedure | object | login |
   database | global | default_object |
   default_procedure [, name]]
```

For more information, see **sp_displayaudit** in the *Adaptive Server Reference Manual*.

Adding User-Specified Records to the Audit Trail

sp_addauditrecord allows users to enter comments into the audit trail. The syntax is:

```
sp_addauditrecord [text] [, db_name] [, obj name]
   [, owner_name] [, dbid] [, objid]
```

All the parameters are optional.

- *text* is the text of the message that you want to add to the *extrainfo* audit table.
- *db_name* is the name of the database referred to in the record, which is inserted into the *dbname* column of the current audit table.
- *obj_name* is the name of the object referred to in the record, which is inserted into the *objname* column of the current audit table.
- *owner_name* is the owner of the object referred to in the record, which is inserted into the *objowner* column of the current audit table.

- *dbid* is an integer value representing the database ID number of *db_name*, which is inserted into the *dbid* column of the current audit table. Do not place it in quotes.
- *objid* is an integer value representing the object ID number of *obj_name*. Do not place it in quotes. *objid* is inserted into the *objid* column of the current audit table.

You can use **sp_addauditrecord** if:

- You have execute permission on **sp_addauditrecord**.
- The auditing configuration parameter was activated with **sp_configure**.
- The **adhoc** auditing option was enabled with **sp_audit**.

By default, only a System Security Officer and the Database Owner of *sybsecurity* can use **sp_addauditrecord**. Permission to execute it may be granted to other users.

Examples of Adding User-Defined Audit Records

The following example adds a record to the current audit table. The text portion is entered into the *extrainfo* column of the current audit table, "corporate" into the *dbname* column, "payroll" into the *objname* column, "dbo" into the *objowner* column, "10" into the *dbid* column, and "1004738270" into the *objid* column:

```
sp_addauditrecord "I gave A. Smith permission to
view the payroll table in the corporate database.
This permission was in effect from 3:10 to 3:30 pm
on 9/22/92.", "corporate", "payroll", "dbo", 10,
1004738270
```

The following example inserts information only into the *extrainfo* and *dbname* columns of the current audit table:

```
sp_addauditrecord @text="I am disabling auditing
briefly while we reconfigure the system",
@db_name="corporate"
```

Querying the Audit Trail

To query the audit trail, use SQL to select and summarize the audit data. If you follow the procedures discussed in "Setting Up Audit Trail Management" on page 8-9, the audit data is automatically archived to one or more tables in another database. For example, assume that the audit data resides in a table called *audit_data* in the

audit_db database. To select audit records for tasks performed by "bob" on July 5, 1993, execute:

```
use audit_db
go
select * from audit_data
  where loginname = "bob"
  and eventtime like "Jul 5% 93"
go
```

This command requests audit records for commands performed in the *pubs2* database by users with the System Security Officer role active:

```
select * from audit_data
  where extrainfo like "%sso_role%
  and dbname = "pubs2"
go
```

This command requests audit records for all table truncations (event 64):

```
select * from audit_data
  where event = 64
go
```

Understanding the Audit Tables

The system audit tables can be accessed only by a System Security Officer, who can read the tables by executing SQL commands. The only commands that are allowed on the system audit tables are **select** and **truncate**.

Table 8-4 describes the columns in all audit tables.

Table 8-4: Columns in each audit table

Column Name	Datatype	Description
event	*smallint*	Type of event being audited. See Table 8-6 on page 8-34.
eventmod	*smallint*	More information about the event being audited. Possible values are: 0 = no modifier for this event 1 = the event passed permission checking 2 = the event failed permission checking
spid	*smallint*	ID of the process that caused the audit record to be written.

Table 8-4: Columns in each audit table (continued)

Column Name	Datatype	Description
eventtime	*datetime*	Date and time that the audited event occurred.
sequence	*smallint*	Sequence number of the record within a single event. Some events require more than one audit record.
suid	*smallint*	Server login ID of the user who performed the audited event.
dbid	*int null*	Database ID in which the audited event occurred, or in which the object, stored procedure, or trigger resides, depending on the type of event.
objid	*int null*	ID of the accessed object, stored procedure, or trigger.
xactid	*binary(6) null*	ID of the transaction containing the audited event. For a multi-database transaction, this is the transaction ID from the database where the transaction originated.
loginname	*varchar(30) null*	Login name corresponding to the *suid*.
dbname	*varchar(30) null*	Database name corresponding to the *dbid*.
objname	*varchar(30) null*	Object name corresponding to the *objid*.
objowner	*varchar(30) null*	Name of the owner of *objid*.
extrainfo	*varchar(255) null*	Additional information about the audited event. This column contains a sequence of items separated by semicolons. For details, see "Reading the extrainfo Column" on page 8-33.

Reading the *extrainfo* Column

The *extrainfo* column contains a sequence of data separated by semicolons. The data is organized in the following categories.

Table 8-5: Information in the extrainfo column

Position	Category	Description
1	Roles	A list of active roles, separated by blanks.
2	Keywords or Options	The name of the keyword or option that was used for the event. For example, for the **alter table** command, the **add column** or **drop constraint** options might have been used. If multiple keywords or options are listed, they are separated by commas.

Table 8-5: Information in the extrainfo column

Position	Category	Description
3	Previous value	If the event resulted in the update of a value, this item contains the value prior to the update.
4	Current value	If the event resulted in the update of a value, this item contains the new value.
5	Other information	Additional security-relevant information that is recorded for the event.
6	Proxy information	The original login name if the event occurred while a **set proxy** was in effect.
7	Principal name	The principal name from the underlying security mechanism if the user's login is the secure default login, and the user logged into Adaptive Server via unified login. The value of this item is NULL if the secure default login is not being used.

This example shows an *extrainfo* column entry for the event of changing an auditing configuration parameter.

```
sso_role;suspend audit when device full;1;0;;ralph;
```

This entry indicates that a System Security Officer changed **suspend audit when device full** from **1** to **0**. There is no "other information" for this entry. The sixth category indicates that the user "ralph" was operating with a proxy login. No principal name is provided.

The other fields in the audit record give other pertinent information. For example, the record contains the server user ID (*suid*) and the login name (*loginname*).

Table 8-6 lists the values that appear in the *event* column, arranged by **sp_audit** option. The "Information in extrainfo" column describes information that might appear in the *extrainfo* column of an audit table, based on the categories described in Table 8-5.

Table 8-6: Values in event and extrainfo columns

Audit Option	Command or Access To Be Audited	*event*	Information in *extrainfo*
(Automatically audited event not controlled by an option)	Enabling auditing with: **sp_configure auditing**	73	-
(Automatically audited event not controlled by an option)	Disabling auditing with: **sp_configure auditing**	74	-

Table 8-6: Values in event and extrainfo columns (continued)

Audit Option	Command or Access To Be Audited	*event*	Information in *extrainfo*
adhoc	User-defined audit record	1	*extrainfo* is filled by the *text* parameter of **sp_addauditrecord**
alter	**alter database**	2	**Keywords or Options:** **alter maxhold** **alter size**
	alter table	3	**Keywords or Options:** **add column** **drop column** **replace column** **add constraint** **drop constraint**
bcp	**bcp in**	4	-
bind	**sp_bindefault**	6	**Other information:** Name of the default
	sp_bindmsg	7	**Other information:** Message ID
	sp_bindrule	8	**Other information:** Name of the rule
create	**create database**	9	-
	create default	14	-
	create procedure	11	-
	create rule	13	-
	create table	10	-
	create trigger	12	-
	create view	16	-
	sp_addmessage	15	**Other information:** Message number
dbaccess	Any access to the database by any user	17	**Keywords or options:** **use cmd** **outside reference**
dbcc	**dbcc (all keywords)**	81	**Keywords or options:** **Any of the dbcc keywords such as checkstorage and the options for that keyword.**
delete	**delete** from a table	18	**Keywords or options:** **delete**
	delete from a view	19	**Keywords or options:** **delete**

Table 8-6: Values in event and extrainfo columns (continued)

Audit Option	Command or Access To Be Audited	*event*	Information in *extrainfo*
disk	**disk init**	20	**Keywords or options:** disk init **Other information: Name of the disk**
	disk mirror	23	**Keywords or options:** disk mirror **Other information: Name of the disk**
	disk refit	21	**Keywords or options:** disk refit **Other information: Name of the disk**
	disk reinit	22	**Keywords or options:** disk reinit **Other information: Name of the disk**
	disk remirror	25	**Keywords or options:** disk remirror **Other information: Name of the disk**
	disk unmirror	24	**Keywords or options:** disk unmirror **Other information: Name of the disk**
drop	**drop database**	26	-
	drop default	31	-
	drop procedure	28	-
	drop table	27	-
	drop trigger	29	-
	drop rule	30	-
	drop view	33	-
	sp_dropmessage	32	**Other information:** Message number
dump	**dump database**	34	-
	dump transaction	35	-
errors	Fatal error	36	**Other information:** *Error number.Severity.State*
	Non-fatal error	37	**Other information:** *Error number.Severity.State*
exec_procedure	Execution of a procedure	38	**Other information:** All input parameters
exec_trigger	Execution of a trigger	39	-

Table 8-6: Values in event and extrainfo columns (continued)

Audit Option	Command or Access To Be Audited	*event*	Information in *extrainfo*
func_obj_access, func_dbaccess	Accesses to objects and databases via Transact-SQL functions	85	-
grant	**grant**	40	-
insert	**insert** into a table	41	**Keywords or options:** If **insert** is used: **insert** If **select into** is used: **insert into** followed by the fully qualified object name
	insert into a view	42	**Keywords or options**: **insert**
load	**load database**	43	-
	load transaction	44	-
login	Any login to the server	45	**Other information**: Host name of the machine from which login was done
logout	Any logouts from the server	46	**Other information**: Host name of the machine from which login was done
reference	Creation of references to tables	91	**Keywords or options**: **reference** **Other information**: Name of the referencing table
revoke	**revoke**	47	-
rpc	Remote procedure call from another server	48	**Keywords or options:** Name of client program **Other information**: Server name, host name of the machine from which the RPC was done.
	Remote procedure call to another server	49	**Keywords or options:** Procedure name
security	**connect to** (CIS only)	90	**Keywords or options:** **connect to**
	kill (CIS only)	89	**Keywords or options:** **kill**
	online database	83	-
	proc_role function (executed from within a system procedure)	80	**Other information:** Required roles

Table 8-6: Values in event and extrainfo columns (continued)

Audit Option	Command or Access To Be Audited	*event*	Information in *extrainfo*
	Regeneration of a password by an SSO	76	**Keywords or options:** Setting SSO password **Other information:** Login name
	Role toggling	55	**Previous value:** **on** or **off** **Current value:** **on** or **off** **Other information:** Name of the role being set
	Server boot	50	**Other information:** **-d***masterdevicename* **-i***interfaces file path* **-S***servername* **-e***errorfilename*
	Server shutdown	51	**Keywords or options:** **shutdown**
	set proxy or **set session authorization**	88	**Previous value:** Previous *suid* **Current value:** New *suid*
	sp_configure	82	**Other information:** • If a parameter is being set: number of configuration parameter • If a configuration file is being used to set parameters: name of the configuration file
	valid_user	85	**Keywords or options:** **valid_user**
select	**select** from a table	62	**Keywords or options:** **select into** **select** **readtext**
	select from a view	63	**Keywords or options:** **select into** **select** **readtext**
setuser	**setuser**	84	**Other information:** Name of the user being set

Table 8-6: Values in event and extrainfo columns (continued)

Audit Option	Command or Access To Be Audited	*event*	Information in *extrainfo*
table_access	delete	18	**Keywords or options:** delete
	insert	41	**Keywords or options:** insert
	select	62	**Keywords or options:** select into select readtext
	update	70	**Keywords or options:** update writetext
truncate	truncate table	64	-
unbind	sp_unbindefault	67	-
	sp_unbindmsg	69	-
	sp_unbindrule	68	-
update	update to a table	70	**Keywords or options:** update writetext
	update to a view	71	**Keywords or options:** update writetext
view_access	delete	19	**Keywords or options:** delete
	insert	42	**Keywords or options:** insert
	select	63	**Keywords or options:** select into select readtext
	update	71	**Keywords or options:** update writetext

9 Managing Remote Servers

This chapter discusses the steps the System Administrator and System Security Officer of each Adaptive Server must execute to enable **remote procedure calls** (RPCs). Topics include:

Overview

Users on a local Adaptive Server can execute stored procedures on a remote Adaptive Server. Executing an RPC sends the results of the remote process to the calling process—usually displayed on the user's screen.

➤ ***Note***

The use of remote servers is not included in the **evaluated configuration**.

To enable RPCs, the System Administrator and System Security Officer of each Adaptive Server must execute the following steps:

- On the local server:
  - (System Security Officer) Use **sp_addserver** to list the local server and remote server in the system table *master..sysservers*.
  - List the remote server in the interfaces file or Directory Service for the local server.
  - Reboot the local server so the global variable *@@servername* is set to the name of the local server. If this variable is not set properly, users cannot execute RPCs from the local server on any remote server.
- On the remote server:
  - (System Security Officer) Use **sp_addserver** to list the server originating the RPC in the system table *master..sysservers*.

- To allow the user who is originating the remote procedure access to the server, a System Security Officer uses **sp_addlogin**, and a System Administrator uses **sp_addremotelogin**.
- Add the remote login name as a user of the appropriate database and grant that login permission to execute the procedure. (If **execute** permission is granted to "public", the user does not need to be granted specific permission.)

Figure 9-1 shows how to set up servers for remote access.

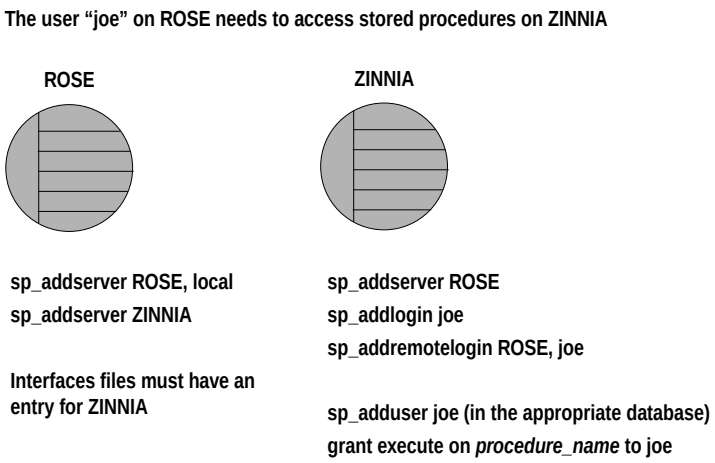

Figure 9-1: Setting up servers to allow remote procedure calls

For operating-system-specific information about handling remote servers, see the the installation documentation for your platform.

Managing Remote Servers

Table 9-1 lists the tasks related to managing remote servers and the system procedures you use to perform the tasks.

Table 9-1: Tasks related to managing remote servers

To	Use	See
Add a remote server	**sp_addserver**	"Adding a Remote Server" on page 9-3
Manage remote server names	**sp_addserver**	"Managing Remote Server Names" on page 9-5
Change server connection options	**sp_serveroption**	"Setting Server Connection Options" on page 9-5
Display information about servers	**sp_helpserver**	"Getting Information About Servers" on page 9-7
Drop a server	**sp_dropserver**	"Dropping Remote Servers" on page 9-7

Adding a Remote Server

A System Security Officer uses **sp_addserver** to add entries to the *sysservers* table. On the server originating the call, you must add one entry for the local server, and one for each remote server that your server will call.

When you create entries for a remote server, you can either:

- Refer to them by the name listed in the interfaces file, or
- Provide a local name for the remote server. For example, if the name in the interfaces file is "MAIN_PRODUCTION," you may want to call it simply "main."

The syntax is:

```
sp_addserver lname [{, local | null}
   [, pname]]
```

where:

- *lname* provides the local "call name" for the remote server. If this name is **not** the same as the remote server's name in the interfaces file, you must provide that name as the third parameter, *pname*.

  The remote server must be listed in the interfaces file on the local machine. If it's not listed, copy the interfaces file entry from the

remote server and append it to your existing interfaces file. Be sure to keep the same port numbers.

- **local** identifies the server being added as a local server. The **local** value is used only after start-up, or after a reboot, to identify the local server name so that it can appear in messages printed out by Adaptive Server. **null** specifies that this server is a remote server.

➤ ***Note***

For users to be able to run RPCs successfully from the local server, the local server must be added with the **local** option and rebooted. The rebooting is required to set the global variable *@@servername*.

- *pname* is the remote server listed in the interfaces file for the server named *lname*. This optional argument permits you to establish local aliases for any other Adaptive Server, Open Server™, or Backup Server that you may need to communicate with. If you do not specify *pname*, it defaults to *lname*.

Examples of Adding Remote Servers

This example creates an entry for the local server named DOCS:

```
sp_addserver DOCS, local
```

The next example creates an entry for a remote server named GATEWAY:

```
sp_addserver GATEWAY
```

To run a remote procedure such as **sp_who** on the GATEWAY server, execute either:

```
GATEWAY.sybsytemprocs.dbo.sp_who
```

or:

```
GATEWAY...sp_who
```

This example gives a remote server called MAIN_PRODUCTION the local alias “main:”

```
sp_addserver main, null, MAIN_PRODUCTION
```

The user can then enter:

```
main...sp_who
```

Managing Remote Server Names

The *master.dbo.sysservers* table has two name columns:

- *srvname* is the unique server name that users must supply when executing remote procedure calls.
- *srvnetname* is the server's network name, which must match the name in the *interfaces* file.

To add or drop servers from your network, you can use **sp_addserver** to update the server's network name in *srvnetname*.

For example, to remove the server MAIN from the network, and move your remote applications to TEMP, you can use the following statement to change the network name, while keeping the local alias:

```
sp_addserver MAIN, null, TEMP
```

sp_addserver displays a message telling you that it is changing the network name of an existing server entry.

Setting Server Connection Options

sp_serveroption sets the server options **timeouts**, **net password encryption**, **rpc security model A**, and **rpc security model B**, which affect connections with remote servers. Additionally, if you have set the remote procedure security model to **rpc security model B**, you can use **sp_serveroption** to set these additional options: **security mechanism**, **mutual authentication**, **use message confidentiality**, and **use message integrity**.

The options you specify for **sp_serveroption** do not affect the communication between Adaptive Server and Backup Server.

The following sections describe **timeouts**, **net password encryption**, **rpc security model A**, and **rpc security model B**. For information about the additional options you can specify when **rpc security model B** is on, see "Establishing Security for Remote Procedures" on page 10-19.

Using the *timeouts* Option

A System Administrator can use the **timeouts** option to disable and enable the normal timeout code used by the local server.

By default, **timeouts** is set to **true**, and the site handler process that manages remote logins times out if there has been no remote user activity for one minute. By setting **timeouts** to **false** on both of the servers involved in remote procedure calls, the automatic timeout is disabled. This example changes **timeouts** to **false**:

```
sp_serveroption GATEWAY, "timeouts", false
```

After you set **timeouts** to **false** on both servers, when a user executes an RPC in either direction, the site handler on each machine runs until one of the servers is shut down. When the server is brought up again, the option remains **false**, and the site handler will be reestablished the next time a user executes an RPC. If users execute RPCs frequently, it is probably efficient in terms of system resources to set this option to **false**, since there is some system overhead involved in setting up the physical connection.

Using the *net password encryption* Option

A System Security Officer can use **net password encryption** to specify whether connections with a remote server are to be initiated with a client-side password encryption handshake or with the usual unencrypted password handshake sequence. The default is **false**.

If **net password encryption** is set to **true**:

1. The initial login packet is sent without passwords.
2. The client indicates to the remote server that encryption is desired.
3. The remote server sends back an encryption key, which the client uses to encrypt its plain text passwords.
4. The client then encrypts its own passwords, and the remote server uses the key to authenticate them when they arrive.

This example sets **net password encription** to **true**:

```
sp_serveroption GATEWAY, "net password encryption",
    true
```

This option does not affect Adaptive Server's interaction with Backup Server.

Using the *rpc security model* Options

The **rpc security model A** and **rpc security model B** options determine what kind of security is available for RPCs. If you use model A, which is the default, Adaptive Server does not support security services such as message confidentiality via encryption between the two servers.

For security model B, the local Adaptive Server gets a credential from the security mechanism and uses the credential to establish a secure physical connection with the remote Adaptive Server. With this model, you can choose one or more of these security services:

mutual authentication, message confidentiality via encryption, and message integrity.

To set security model A for the server GATEWAY, execute:

```
sp_serveroption GATEWAY, "rpc security model A",
    true
```

For information about how to set up servers for Security Model B, see "Establishing Security for Remote Procedures" on page 10-19.

Getting Information About Servers

sp_helpserver reports on servers. Without an argument, it provides information about all the servers listed in *sysservers*. When you include a server name, it provides information about that server only. The syntax is:

```
sp_helpserver [server]
```

sp_helpserver checks for both *srvname* and *srvnetname* in the *master..sysremotelogins* table.

For operating-system-specific information about setting up remote servers, see the the installation documentation for your platform.

Dropping Remote Servers

A System Security Officer can use the **sp_dropserver** system procedure to drop servers from *sysservers*. The syntax is:

```
sp_dropserver server [, droplogins]
```

where:

- *server* is the name of the server you want to drop.
- **droplogins** allows you to drop a remote server and all of that server's remote login information in one step. If you do not use **droplogins**, you cannot drop a server that has remote logins associated with it.

The following statement drops the GATEWAY server and all of the remote logins associated with it:

```
sp_dropserver GATEWAY, droplogins
```

You don't have to use **droplogins** if you want to drop the local server; that entry does not have remote login information associated with it.

Adding Remote Logins

The System Security Officer and System Administrator of any Adaptive Server share control over which remote users can access the server, and what identity the remote users assume. The System Administrator uses **sp_addremotelogin** to add remote logins and **sp_dropremotelogin** to drop remote logins. The System Security Officer uses **sp_remoteoption** to control whether password checking will be required.

Mapping Users' Server IDs

Logins from a remote server can be mapped to a local server in three ways:

- A particular remote login can be mapped to a particular local login name. For example, user "joe" on the remote server might be mapped to "joesmith".
- All logins from one remote server can be mapped to one local name. For example, all users sending remote procedure calls from the MAIN server might be mapped to "remusers".
- All logins from one remote server can use their remote names.

The first option can be combined with the other two options, and its specific mapping takes precedence over the other two more general mappings. The second and third options are mutually exclusive; you can use either of them, but not both.

To change the mapping option:

Use **sp_dropremotelogin** to remove the old mapping.

Use **sp_addremotelogin** to add remote logins. The syntax is:

```
sp_addremotelogin remoteserver [, loginame
   [, remotename]]
```

If the local names are not listed in *master..syslogins*, add them as Adaptive Server logins with **sp_addlogin** before adding the remote logins.

Only a System Administrator can execute **sp_addremotelogin**. For more information, see the *Adaptive Server Reference Manual*.

Mapping Remote Logins to Particular Local Names

The following example maps the login named "pogo" from a remote system to the local login name "bob". The user logs in to the remote system as "pogo". When that user executes remote procedure calls from GATEWAY, the local system maps the remote login name to "bob".

```
sp_addlogin bob
sp_addremotelogin GATEWAY, bob, pogo
```

Mapping All Remote Logins to One Local Name

The following example creates an entry that maps all remote login names to the local name "albert". All names are mapped to "albert", except those with specific mappings, as described in the previous section. For example, if you mapped "pogo" to "bob", and then the rest of the logins to "albert", "pogo" still maps to "bob".

```
sp_addlogin albert
sp_addremotelogin GATEWAY, albert
```

If you use **sp_addremotelogin** to map all users from a remote server to the same local name, use **sp_remoteoption** to specify the "trusted" option for those users. For example, if all users from server GATEWAY that are mapped to "albert" are to be trusted, specify:

```
sp_remoteoption GATEWAY, albert, NULL, trusted
    true
```

If you do not specify the logins as trusted, the logins will not be allowed to execute RPCs on the local server unless they specify passwords for the local server when they log in to the remote server. Users, when they use Open Client Client-Library can use the routine **ct_remote_pwd** to specify a password for server-to-server connections. **isql** and **bcp** do not permit users to specify a password for RPC connections. See "Password Checking for Remote Users" on page 9-12 for more information about **sp_remoteoption**.

◆ ***WARNING!***

Do not map more than one remote login to a single local login, as it reduces individual accountability on the server. Audited actions can be traced only to the local server login, not to the individual logins on the remote server.

If users are logged into the remote server using "unified login", the logins must also be trusted on the local server, or they must specify passwords for the server when they log into the remote server. For information about "unified login", see "Using Unified Login" on page 10-13.

◆ ***WARNING!***

Using the trusted mode of sp_remoteoption reduces the security of your server, as passwords from such "trusted" users are not verified.

Keeping Remote Login Names for Local Servers

To enable remote users to keep their remote login names while using a local server:

1. Use **sp_addlogin** to create a login for each login from the remote server.
2. Use **sp_addremotelogin** for the server as a whole to create an entry in *master..sysremotelogins* with a null value for the remote login name and a value of -1 for the *suid*. For example:

   ```
   sp_addremotelogin GATEWAY
   ```

Example of Remote User Login Mapping

This statement displays the local and remote server information recorded in *master..sysservers*:

```
select srvid, srvname from sysservers

srvid  srvname
-----  ----------
    0  SALES
    1  CORPORATE
    2  MARKETING
    3  PUBLICATIONS
    4  ENGINEERING
```

The SALES server is local. The other servers are remote.

This statement displays information about the remote servers and users stored in *master..sysremotelogins*:

```
select remoteserverid, remoteusername, suid
  from sysremotelogins
```

```
remoteserverid   remoteusername   suid
--------------   --------------   ------
1                joe              1
1                nancy            2
1                NULL             3
3                NULL             4
4                NULL             -1
```

By matching the value of *remoteserverid* in this result and the value of *srvid* in the previous result, you can find the name of the server for which the *remoteusername* is valid. For example, in the first result, *srvid* 1 indicates the CORPORATE server; in the second result *remoteserverid* 1 indicates that same server. Therefore, the remote user login names "joe" and "nancy" are valid on the CORPORATE server.

The following statement shows the entries in *master..syslogins*:

```
select suid, name from syslogins
```

```
suid    name
------  ------------
    1   sa
    2   vp
    3   admin
    4   writer
```

The results of all three queries together show:

- The remote user name "joe" (*suid* 1) on the remote CORPORATE server (*srvid* and *remoteserverid* 1) is mapped to the "sa" login (*suid* 1).
- The remote user name "nancy" (*suid* 2) on the remote CORPORATE server (*srvid* and *remoteserverid* 1) is mapped to the "vp" login (*suid* 2).
- The other logins from the CORPORATE server (*remoteusername* "NULL") are mapped to the "admin" login (*suid* 3).
- All logins from the PUBLICATIONS server (*srvid* and *remoteserverid* 3) are mapped to the "writer" login (*suid* 4).
- All logins from the ENGINEERING server (*srvid* and *remoteserverid* 4) are looked up in *master..syslogins* by their remote user names (*suid* -1).
- There is no *remoteserverid* entry for the MARKETING server in *sysremotelogins*. Therefore, users who log in to the MARKETING server cannot run remote procedure calls from that server.

The remote user mapping procedures and the ability to set permissions for individual stored procedures give you control over

which remote users can access local procedures. For example, you can allow the "vp" login from the CORPORATE server to execute certain local procedures and all other logins from CORPORATE to execute the procedures for which the "admin" login has permission.

➤ ***Note***

In many cases, the passwords for users on the remote server must match passwords on the local server.

Password Checking for Remote Users

A System Security Officer can use **sp_remoteoption** to determine whether passwords will be checked when remote users log in to the local server. By default, passwords are verified ("untrusted" mode). In **trusted** mode, the local server accepts remote logins from other servers and front-end applications without user-access verification for the particular login.

When **sp_remoteoption** is used with arguments, it changes the mode for the named user. The syntax is:

```
sp_remoteoption [remoteserver, loginame, remotename,
   optname, {true | false}]
```

The following example sets **trusted** mode for the user "bob":

```
sp_remoteoption GATEWAY, pogo, bob, trusted,
    true
```

Effects of Using the Untrusted Mode

The effects of the "untrusted" mode depend on the user's client program. **isql** and some user applications require that logins have the same password on the remote server and the local server. Open Client™ applications can be written to allow local logins to have different passwords on different servers.

To change your password in "untrusted" mode, you must first change it on all the remote systems you access before changing it on your local server. This is because of the password checking. If you change your password on the local server first, when you issue the remote procedure call to execute **sp_password** on the remote server your passwords will no longer match.

The syntax for changing your password on the remote server is:

remote_server*...sp_password *caller_passwd, new_passwd

On the local server, the syntax is:

sp_password *caller_passwd, new_passwd*

See "Changing Passwords" on page 6-24 for more information about changing your password.

Getting Information About Remote Logins

sp_helpremotelogin prints information about the remote logins on a server. The following example shows the remote login "pogo" mapped locally to login name "bob", with all other remote logins keeping their remote names.

```
sp_helpremotelogin
server      remote_user_name      local_user_name       options
-------     ----------------      -----------------     --------
GATEWAY     **mapped locally**    **use local name**    untrusted
GATEWAY     pogo                  bob                   untrusted
```

Configuration Parameters for Remote Logins

Table 9-2 shows the configuration parameters that affect RPCs. All these configuration parameters are set using **sp_configure** and do not take effect until Adaptive Server is restarted.

Table 9-2: Configuration parameters that affect RPCs

Configuration Parameter	Default
allow remote access	1
number of remote logins	20
number of remote sites	10
number of remote connections	20
remote server pre-read packets	3

Allowing Remote Access

To allow remote access to or from a server, including Backup Server, set **allow remote access** to 1:

```
sp_configure "allow remote access", 1
```

To disallow remote access at any time, set **allow remote access** to 0:

```
sp_configure "allow remote access", 0
```

Only a System Security Officer can set the **allow remote access** parameter.

➤ ***Note***

You cannot perform database or transaction log dumps while the **allow remote access** parameter is set to 0.

Controlling the Number of Active User Connections

To **set** the number of active user connections from this site to remote servers, use **number of remote logins**. This command sets **number of remote logins** to 50:

```
sp_configure "number of remote logins", 50
```

Only a System Administrator can set the **number of remote logins** parameter.

Controlling the Number of Remote Sites

To control the number of remote sites that can access a server simultaneously, use **number of remote sites**. All accesses from an individual site are managed by one site handler. This parameter controls the number of site handlers, not the number of individual, simultaneous procedure calls. For example, if you set **number of remote sites** to 5, and each site initiates three remote procedure calls, **sp_who** shows 5 site handler processes for the 15 processes. Only a System Administrator can set the number of remote sites.

Controlling the Number of Active Remote Connections

To control the limit on active remote connections that are initiated to and from a server, use the **number of remote connections** parameter. This parameter controls connections initiated from the server and connections initiated from remote sites to the server. Only a System Administrator can set **number of remote connections**.

Controlling Number of Preread Packets

To reduce the needed number of connections, all communication between two servers is handled through one site handler. This site

handler can preread and keep track of data packets for each user before the user process that needs them is ready.

To control how many packets a site handler will preread, use **remote server pre-read packets**. The default value, 3, is adequate in all cases; higher values can use too much memory. Only a System Administrator can set **remote server pre-read packets**. For more information, see “remote server pre-read packets” on page 17-96.

10 Using Network-Based Security

This chapter describes the network-based security services that enable you to authenticate users and protect data transmitted among machines on a network. Topics include:

Overview

In a distributed client / server computing environment intruders can view or tamper with confidential data. Adaptive Server works with third-party providers to give you security services that:

- Authenticate users, clients, and servers – Make sure they are who they say they are.
- Provide data confidentiality with encryption – Ensure that data cannot be read by an intruder.
- Provide data integrity – Prevent data tampering and detect when it has occurred

Table 10-1 lists the security mechanisms supported by Adaptive Server on UNIX and desktop platforms:

Table 10-1: Security mechanisms supported by Adaptive Server

UNIX Platforms	Desktop Platforms
Distributed Computing Environment (DCE)	Windows NT LAN Manager

Table 10-1: Security mechanisms supported by Adaptive Server

UNIX Platforms	Desktop Platforms
CyberSAFE Kerberos	

How Applications Use Security Services

The following illustration shows a client application using a security mechanism to ensure a secure connection with Adaptive Server.

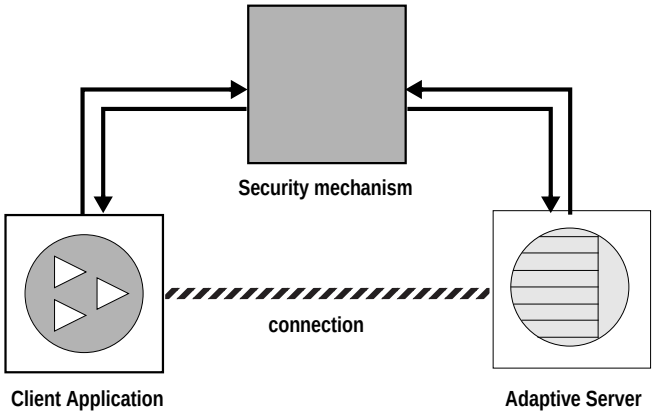

Figure 10-1: Establishing secure connections between a client and Adaptive Server

The secure connection between a client and a server can be used for:

- Login authentication
- Message protection

Login Authentication

If a client requests authentication services:

1. The client validates the login with the security mechanism. The security mechanism returns a **credential**, which contains security-relevant information.
2. The client sends the credential to Adaptive Server.

3. Adaptive Server authenticates the client's credential with the security mechanism. If the credential is valid, a secure connection is established between the client and Adaptive Server.

Message Protection

If the client requests message protection services:

1. The client uses the security mechanism to prepare the data packet it will send to Adaptive Server.

   Depending upon which security services are requested, the security mechanism might encrypt the data or create a cryptographic signature associated with the data.
2. The client sends the data packet to Adaptive Server.
3. When Adaptive Server receives the data packet, it uses the security mechanism to perform any required decryption and validation.
4. Adaptive Server returns results to the client, using the security mechanism to perform the security functions that were requested; for example, Adaptive Server may return the results in encrypted form.

Security Services and Adaptive Server

Depending upon the security mechanism you choose, Adaptive Server allows you to use one or more of these security services:

- Unified login –Authenticate users **once** without requiring them to supply a name and password every time they log in to an Adaptive Server.
- Message confidentiality – Encrypt data over the network.
- Mutual authentication – Verify the identity of the client and the server. This must be requested by the client and cannot be required by Adaptive Server.
- Message integrity – Verify that data communications have not been modified.
- Replay detection – Verify that data has not been intercepted by an intruder.
- Out-of-sequence check – Verify the order of data communications.

- Message origin checks – Verify the origin of the message.
- Remote procedure security – Establish mutual authentication, message confidentiality, and message integrity for remote procedure communications.

➤ ***Note***

The security mechanism you are using may not all of these services. For information about what services are available to you, see "Getting Information About Available Security Services" on page 10-30.

Administering Network-Based Security

Table 10-2 provides an overall process for using the network-based security functions provided by Adaptive Server. You must install Adaptive Server before you can complete the steps in Table 10-2.

Table 10-2: Process for administering network-based security

Step	Description	See
1. Set up the configuration files: – *libtcl.cfg* – *objectid.dat* – interfaces (or Directory Service)	Edit the *libtcl.cfg* file. Edit the *objectid.dat* file. Edit the *interfaces* file or Directory Service.	"Setting Up Configuration Files for Security" on page 10-5. The *Open Client/Server Configuration Guide* for your platform.
2. Make sure the security administrator for the security mechanism has created logins for each user and for the Adaptive Server and Backup Server.	The security administrator must add names and passwords for users and servers in the security mechanism. For DCE, the security administrator needs to create a *keytab* file for server entries.	The documentation supplied with your security mechanism. "Identifying Users and Servers to the Security Mechanism" on page 10-11.
3. Configure security for your installation.	Use **sp_configure**.	"Configuring Adaptive Server for Security" on page 10-12.
4. Restart Adaptive Server.	Activates the **use security services** parameter.	"Restarting the Server to Activate Security Services" on page 10-17.
5. Add logins to Adaptive Server to support enterprise-wide login.	Use **sp_addlogin** to add users. Optionally, specify a default secure login with **sp_configure**.	"Adding Logins to Support Unified Login" on page 10-18.

Table 10-2: Process for administering network-based security (continued)

Step	Description	See
6. Determine the security model for remote procedures and set up the local and remote servers for RPC security.	Use **sp_serveroption** to choose the security model (A or B).	"Establishing Security for Remote Procedures" on page 10-19.
7. Connect to the server and use security services.	Use **isql_dce** (if you are using DCE library services or security services) or Open Client Client-Library to connect to Adaptive Server, specifying the security services you want to use.	"Connecting to the Server and Using the Security Services" on page 10-27. The *Open Client/Server Configuration Guide* for your platform. "Security Features" topics page in the *Open Client Client-Library/C Reference Manual.*
8. Check the security services and security mechanisms that are available.	Use the functions **show_sec_services** and **is_sec_services_on** to check which security services are available. For a list of security mechanisms and their security services supported by Adaptive Server, use **select** to query the *syssecmechs* system table.	"Getting Information About Available Security Services" on page 10-30.

Setting Up Configuration Files for Security

Configuration files are created during installation at a default location in the Sybase directory structure. Table 10-3 provides an overview of the configuration files required for using network-based security.

Table 10-3: Names and locations for configuration files

File Name	Description	Location
libtcl.cfg	The driver configuration file contains information regarding directory, security, and network drivers and any required initialization information.	**UNIX platforms:** *$SYBASE/config* **Desktop platforms:** *SYBASE_home\ini*

Table 10-3: Names and locations for configuration files (continued)

File Name	Description	Location
objectid.dat	The object identifiers file maps global object identifiers to local names for character set, collating sequence, and security mechanisms.	**UNIX platforms:** *$SYBASE/config* **Desktop platforms:** *SYBASE_home\ini*
UNIX: *interfaces* Desktop Platforms: *sql.ini*	The interfaces file contains connection and security information for each server listed in the file. **Note:** In this release, you can use a Directory Service instead of the interfaces file.	**UNIX platforms:** *$SYBASE* **Desktop platforms:** *SYBASE_home\ini*

For a detailed description of the configuration files, see the *Open Client/Server Configuration Guide* for your platform.

Preparing *libtcl.cfg* to Use Network-Based Security

libtcl.cfg contains information about three types of drivers:

- Network (Net-Library)
- Directory Services
- Security

A **driver** is a Sybase library that provides an interface to an external service provider. Drivers are dynamically loaded so that you can change the driver used by an application without re-linking the application.

Entries for Network Drivers

The syntax for a network driver entry is:

```
driver=protocol description
```

where:

- *driver* is the name of the network driver.
- *protocol* is the name of the network protocol.
- *description* is a description of the entry. This element is optional.

➤ ***Note***

If you do not specify a network driver, an appropriate driver for your application and platform is automatically used. For example, for UNIX platforms, a driver that can handle threads is automatically chosen when security services are being used.

Entries for Directory Services

Entries for Directory Services apply if you want to use a Directory Service instead of the interfaces file. For information about directory entries, see the configuration documentation for your platform, and the *Open Client/Server Configuration Guide* for your platform.

Entries for Security Drivers

The syntax for a security driver entry is:

provider=driver init-string

where:

- *provider* is the local name for the security mechanism. The mapping of the local name to a global object identifier is defined in *objectid.dat*.

  The default local names are:

  - "dce" – For the DCE security mechanism.
  - "csfkrb5" – For the CyberSAFE Kerberos security mechanism.
  - "LIBSMSSP" – For Windows LAN Manager on Windows NT or Windows 95 (clients only).

  If you use a local mechanism name other than the default, you must change the local name in the *objectid.dat* file (see "The objectid.dat File" on page 10-9 for an example).
- *driver* is the name of the security driver. The default location of all drivers for UNIX platforms is *$SYBASE/lib*. The default location for desktop platforms is *SYBASE_home\dll*.
- *init-string* is an initialization string for the driver. This element is optional. The value for *init-string* varies by driver:

  - For the DCE driver, the syntax for *init-string* is:

    secbase=/.../*cell_name*

where *cell_name* is the name of your DCE cell.

- For the CyberSAFE Kerberos driver, the syntax for *init-string* is:

  secbase=@*realm*

  where *realm* is the default CyberSAFE Kerberos realm name.

- For the Windows NT LAN Manager, *init-string* is not applicable.

UNIX Platform Information

This section contains information specific to UNIX platforms. For more information, see the *Open Client/Server Configuration Guide for UNIX*.

For UNIX platforms, no special tools for editing the *libtcl.cfg* file are available. Use your favorite editor to comment and uncomment the entries that are already in place after you install Adaptive Server.

The *libtcl.cfg* file, after installation of Adaptive Server on a UNIX platform, already contains entries for the three sections of the file:

- [DRIVERS]
- [DIRECTORY]
- [SECURITY]

The sections do not have to be in a specific order.

Make sure that the entries you do not want to use are commented (begin with ";") and the entries you want are uncommented (do not begin with ";").

Sample libtcl.cfg File for Sun Solaris

```
[DRIVERS]
;libtli.so=tcp unused ; This is the non-threaded tli driver.
;libtli_r.so=tcp unused ; This is the threaded tli driver.


[DIRECTORY]
;dce=libddce.so ditbase=/.:/subsys/sybase/dataservers
;dce=libddce.so ditbase=/.:/users/cfrank


[SECURITY]
dce=libsdce.so secbase=/.../svrsole4_cell
```

This *libtcl.cfg* file is set up to use the DCE security service. Notice that this file does not use Directory Services because all [DIRECTORY] section entries are commented.

Because all entries in the [DRIVERS] section for network drivers are also commented, appropriate drivers are chosen automatically by the system. A threaded driver is chosen automatically when security services are being used, and a non-threaded driver is chosen automatically for applications that cannot work with threaded drivers. For example, Backup Server does not support security services and does not work with a threaded driver.

Desktop Platform Information

This section contains information specific to desktop platforms. For more information, see the *Open Client/Server Configuration Guide for Desktop Platforms*.

Use the **ocscfg** utility to edit the *libtcl.cfg* file. See the *Open Client/Server Configuration Guide for Desktop Platforms* for instructions for using *ocscfg*.

The **ocscfg** utility creates section headings automatically for the *libtcl.cfg* file.

Sample libtcl.cfg File for Desktop Platforms

```
[NT_DIRECTORY]
ntreg_dsa=LIBDREG  ditbase=software\sybase\serverdsa

[DRIVERS]
NLWNSCK=TCP  Winsock TCP/IP Net-Lib driver
NLMSNMP=NAMEPIPE  Named Pipe Net-Lib driver
NLNWLINK=SPX  NT NWLINK SPX/IPX Net-Lib driver
NLDECNET=DECNET  DecNET Net-Lib driver

[SECURITY]
NTLM=LIBSMSSP
```

The *objectid.dat* File

The *objectid.dat* file maps global object identifiers, such as the one for the DCE service (“1.3.6.1.4.1.897.4.6.1”) to local names, such as “dce”. The file contains sections such as [CHARSET] for character sets and [SECURITY] for security services. Of interest here is the security section. Following is a sample *objectid.dat* file:

```
[secmech]
    1.3.6.1.4.1.897.4.6.1   = dce
    1.3.6.1.4.1.897.4.6.3   = NTLM
    1.3.6.1.4.1.897.4.6.6   = csfkrb5
```

You need to change this file only if you have changed the local name of a security service in the *libtcl.cfg* file. Use a text editor to edit the file.

For example, if you changed

```
[SECURITY]
dce=libsdce.so secbase=/.../svrsole4_cell
```

to

```
[SECURITY]
dce_group=libsdce.so secbase=/.../svrsole4_cell
```

in *libtcl.cfg*, then you need to change the *objectid.dat* file to reflect the change. Simply change the local name in the line for DCE in *objectid.dat*:

```
1.3.6.1.4.1.897.4.6.1   = dce_group
```

➤ ***Note***

You can specify only one local name per security mechanism.

Specifying Security Information for the Server

You can choose to use an **interfaces** file or a **Directory Service** to provide information about the servers in your installation.

The interfaces file contains network and security information for servers. If you plan to use security services, the interfaces file must include a “secmech” line, which gives the global identifier or identifiers of the security services you plan to use.

Instead of using the interfaces file, Adaptive Server supports Directory Services to keep track of information about servers. A Directory Service manages the creation, modification, and retrieval of information about network servers. The advantage of using a Directory Service is that you do not need to update multiple interfaces files when a new server is added to your network or when a server moves to a new address. If you plan to use security services with a Directory Service, the *secmech* security attribute must be defined. It must point to one or more global identifiers of the security services you plan to use.

UNIX Tools for Specifying the Security Mechanism

To specify the security mechanism or mechanisms you want to use:

- If you are using the *interfaces* file, use the **dscp** utility.
- If you are using a Directory Service, use the **dscp_dce** utility.

➤ ***Note***

The **dsedit** tool, which helps you create entries for either the *interfaces* file or a Directory Service, is available on UNIX platforms. However, it does not support the creation of *secmech* entries for security mechanisms.

For more information about **dscp**, see the *Open Client/Server Configuration Guide for UNIX*.

Desktop Tools for Specifying Server Attributes

To provide information about the servers for your installation in the *sql.ini* file or a Directory Service, use the **dsedit** utility. This utility provides a graphical user interface for specifying server attributes such as the server version, name, and security mechanism. For the security mechanism attribute, you can specify one or more object identifiers for the security mechanisms you plan to use. For information about using **dsedit**, see the *Open Client/Server Configuration Guide for Desktop Platforms*.

Identifying Users and Servers to the Security Mechanism

The security administrator for the security mechanism must define **principals**, which include both users and servers, to the security

mechanism. Table 10-4 lists tools you can use to add users and servers.

Table 10-4: Defining users and servers to the security mechanism

Security Mechanism	Command or Tool
DCE	Use the DCE **dcecp** tool's **user create** command to create a new principal (user or server). In addition, use the **keytab create** command to create a DCE keytab file, which contains a principal's password in encrypted form. When you are defining a server to DCE, use command options that specify that the new principal can act as a server.
CyberSAFE Kerberos	Use the CyberSAFE **kadmin** utility's **add** command. In addition, use the **kadmin** utility, with the **ext** command to create a key in a CyberSAFE Kerberos server key table file. When you are defining a server to CyberSAFE Kerberos, use command options that specify that the new principal can act as a server.
Windows NT LAN Manager	Run the User Manager tool to define users to the Windows NT LAN Manager. Be sure to define the Adaptive Server name as a user to Windows NT LAN Manager and bring up Adaptive Server as that user name.

➤ ***Note***

In a production environment, you must control the access to files that contain the keys of the servers and users. If users can access the keys, they can create a server that impersonates your server.

Refer to the documentation available from the third-party provider of the security mechanism for detailed information about how to perform required administrative tasks.

Configuring Adaptive Server for Security

Adaptive Server includes several configuration parameters for administering network-based security. To set these parameters, you must be a System Security Officer. All parameters for network-based security are part of the "Security-Related" configuration parameter group.

Configuration parameters are used to:

- Enable network-based security
- Require unified login
- Require message confidentiality with data encryption
- Require one or more message integrity security services

Enabling Network-Based Security

To enable or disable network-based security, use **sp_configure** to set the **use security services** configuration parameter. Set this parameter to 1 to enable network-based security. If this parameter is 0 (the default), network-based security services are not available. The syntax is:

```
sp_configure "use security services", [0|1]
```

For example, to enable security services, execute:

```
sp_configure “use security services”, 1
```

➤ ***Note***

This configuration parameter is static; you must restart Adaptive Server for it to take effect. See “Restarting the Server to Activate Security Services” on page 10-17.

Using Unified Login

Configuration parameters are available to:

- Require unified login
- Establish a default secure login

All the parameters for unified login take effect immediately. You must be a System Security Officer to set the parameters.

Requiring Unified Login

To require all users to already be authenticated by a security mechanism, set the **unified login required** configuration parameter to 1. If this parameter is 0 (the default), Adaptive Server will accept traditional login names and passwords, as well as already-authenticated credentials. The syntax is:

```
sp_configure "unified login required", [0|1]
```

For example, to require all logins to be authenticated by a security mechanism, execute:

```
sp_configure "unified login required", 1
```

Establishing a Secure Default Login

When a user with a valid credential from a security mechanism logs in to Adaptive Server, the server checks whether the user name exists in *master..syslogins*. If it does, that user name is used by Adaptive Server. For example, if a user logs in to the DCE security mechanism as "ralph," and "ralph" is a name in *master..syslogins*, Adaptive Server uses all roles and authorizations defined for "ralph" in the server.

However, if a user with a valid credential logs into Adaptive Server, but is unknown to the server, the login is accepted only if a **secure default login** is defined with **sp_configure**. Adaptive Server uses the default login for any user who is not defined in *master..syslogins*, but who is pre-authenticated by a security mechanism. The syntax is:

```
sp_configure "secure default login", 0, login_name
```

The default value for **secure default login** is "guest."

This login must be a valid login in *master..syslogins*. For example, to set the login "gen_auth" to be the default login:

1. Use **sp_addlogin** to add the login as a valid user in Adaptive Server:

   ```
   sp_addlogin gen_auth, pwgenau
   ```

   This procedure sets the initial password to "pwgenau"

2. Use **sp_configure** to designate the login as the security default.

   ```
   sp_configure "secure default login", 0, gen_auth
   ```

   Adaptive Server will use this login for a user who is pre-authenticated by a security mechanism but is unknown to Adaptive Server.

➤ ***Note***

More than one user can assume the *suid* associated with the secure default login. Therefore, you might want to activate auditing for all activities of the default login. You may also want to consider using **sp_addlogin** to add all users to the server.

For more information about adding logins, see “Adding Logins to Support Unified Login” on page 10-18 and “Adding Logins to Adaptive Server” on page 6-3.

Mapping Security Mechanism Login Names to Server Names

Some security mechanisms may allow login names that are not valid in Adaptive Server. For example, login names that are longer than 30 characters, or login names containing special characters such as !, %, *, and & are invalid names in Adaptive Server. All login names in Adaptive Server must be valid identifiers. For information about what identifiers are valid, see Appendix , “Expressions, Identifiers, and Wildcard Characters” in the *Adaptive Server Reference Manual.*

Table 10-5 shows how Adaptive Server converts invalid characters in login names:

Table 10-5: Conversion of invalid characters in login names

Invalid Characters	Converts To
Ampersand & Apostrophe ’ Backslash \ Colon : Comma , Equals sign = Left quote ‘ Percent % Right angle bracket > Right quote ’ Tilde ~	Underscore _
Caret ^ Curly braces { } Exclamation point ! Left angle bracket < Parenthesis ( ) Period . Question mark ?	Dollar sign $
Asterisk * Minus sign - Pipe | Plus sign + Quotation marks " Semicolon ; Slash / Square brackets [ ]	Pound sign #

Requiring Message Confidentiality with Encryption

To require all messages into and out of Adaptive Server to be encrypted, set the **msg confidentiality reqd** configuration parameter to 1. If this parameter is 0 (the default), message confidentiality is not required but may be established by the client.

The syntax for setting this parameter is:

```
sp_configure configuration_parameter, [0 | 1]
```

For example, to require that all messages be encrypted, execute:

```
sp_configure "msg confidentiality reqd", 1
```

Requiring Data Integrity

Adaptive Server allows you to use the following configuration parameters to require that one or more types of data integrity be checked for all messages:

- **msg integrity reqd** – set this parameter to 1 to require that all messages be checked for general tampering. If this parameter is 0 (the default), message integrity is not required but may be established by the client if the security mechanism supports it.

Memory Requirements for Network-Based Security

Allocate approximately 2K additional memory per secure connection. The value of the **total memory** configuration parameter specifies the number of 2K blocks of memory that Adaptive Server requires at start-up. For example, if you expect the maximum number of secure connections occurring at the same time to be 150, increase the **total memory** parameter by 150, which increases memory allocation by 150 2K blocks.

The syntax is:

```
sp_configure total memory, value
```

For example, if Adaptive Server requires 25,000 2K blocks of memory, including the increased memory for network-based security, execute:

```
sp_configure "total memory", 25000
```

For information about estimating and specifying memory requirements, see the Chapter 14, “Configuring Memory.”

Restarting the Server to Activate Security Services

Once you have configured security services, you must restart Adaptive Server.

For Windows NT, see the configuration documentation for your platform.

For UNIX platforms, note that:

- After you complete the installation of Adaptive Server, your *runserver* file contains an invocation of the **dataserver** utility to start Adaptive Server.
- Two versions of the **dataserver** utility are available: **dataserver_dce** and **dataserver.** Likewise, two versions of the **diagserver** are available: **diagserver_dce** and **diagserver.** The utility you use depends on the platform you use:
  - For Sun Solaris platforms, use **dataserver_dce** if you plan to use security services and **dataserver** if you do not plan to use security services.
  - For HP and RS/6000 platforms, use **dataserver** and **diagserver.** You can use a single binary, whether or not you are using security services.
- If you are using the DCE security service, be sure you have defined the *keytab* file. You can specify the **-K** option to **dataserver_dce** to specify the location of the *keytab* file. If you do not specify a location, Adaptive Server assumes the file is located in *$SYBASE/config/$DSLISTEN_key.* Optionally, you can specify the location as follows:

  ```
  $SYBASE/bin/dataserver_dce -Stest4 -dd_master
     -K/opt/dcelocal/keys/test4_key
  ```

  This **dataserver_dce** command boots the server using the master device *d_master* and the *keytab* file stored in */opt/dcelocal/keys/test4_key.*

  If you are using the default location for *keytab,* and $DSLISTEN is set to the name of your server (test4), you can execute:

  ```
  $SYBASE/bin/dataserver_dce -dd_master
  ```

  Then, Adaptive Server looks for the *keytab* file in *$SYBASE/config/test4_key.*

  For information about setting up your *keytab* file for DCE, refer to the DCE administrative documentation.

Determining Security Mechanisms to Support

use security services is set to 0, Adaptive Server supports no security mechanisms.

If **use security services** is set to 1, Adaptive Server supports a security mechanism when both of the following circumstances are true:

- The security mechanism's global identifier is listed in the interfaces file or Directory Service.
- The global identifier is mapped in *objectid.dat* to a local name that is listed in *libtcl.cfg*.

For information about how Adaptive Server determines which security mechanism to use for a particular client, see "Using Security Mechanisms for the Client" on page 10-30.

Adding Logins to Support Unified Login

When users log in to Adaptive Server with a pre-authenticated credential, Adaptive Server:

1. Checks whether the user is a valid user in *master..syslogins*. If the user is listed in *master..syslogins*, Adaptive Server accepts the login without requiring a password.
2. If the user name is not in *master..syslogins*, Adaptive Server checks whether a default secure login is defined. If the default login is defined, the user is logged in successfully as that login. If a default login is not defined, Adaptive Server rejects the login.

Therefore, consider whether you want to allow only those users who are defined as valid logins to use Adaptive Server, or whether you want users to be able to login with the default login. You must add the default login in *master..syslogins* and use **sp_configure** to define the default. For details, see "Establishing a Secure Default Login" on page 10-14.

General Procedure for Adding Logins

Follow the general procedure described in Table 10-6 to add logins to the server and, optionally, to add users to one or more databases with appropriate roles and authorizations to one or more databases.

Table 10-6: Adding logins and authorizing database access

Task	Required Role	Command or Procedure	See
1. Add a login for the user.	System Security Officer	**sp_addlogin**	"Adding Logins to Adaptive Server" on page 6-3
2. Add the user to one or more databases.	System Administrator or Database Owner	**sp_adduser** Execute this procedure from within the database.	"Adding Users to Databases" on page 6-6
3. Add the user to a group in a database.	System Administrator or Database Owner	**sp_changegroup** Execute this procedure from within the database.	"Changing a User's Group Membership" on page 6-26 **sp_changegroup** in the *Adaptive Server Reference Manual*
4. Grant system roles to the user.	System Administrator or System Security Officer	**grant role**	"Creating and Assigning Roles to Users" on page 6-11 **grant** in the *Adaptive Server Reference Manual*
5. Create user-defined roles and grant the roles to users.	System Security Officer	**create role** **grant role**	"Creating and Assigning Roles to Users" on page 6-11 **grant** in the *Adaptive Server Reference Manual* **create role** in the *Adaptive Server Reference Manual*
6. Grant access to database objects.	Database object owners		Chapter 7, "Managing User Permissions"

Establishing Security for Remote Procedures

Adaptive Server acts as the client when it connects to another server to execute a remote procedure call (RPC) as shown in Figure 10-2.

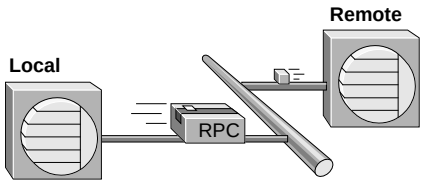

Figure 10-2: Adaptive Server acting as client to execute an RPC

One **physical** connection is established between the two servers. The servers use the physical connection to establish one or more **logical** connections—one logical connection for each RPC.

Adaptive Server 11.5 supports two security models for RPCs: **security model A** and **security model B**.

Security Model A

For security model A, Adaptive Server does not support security services such as message confidentiality via encryption between the two servers. Security Model A is the default.

Security Model B

For security model B, the local Adaptive Server gets a credential from the security mechanism and uses the credential to establish a secure physical connection with the remote Adaptive Server. With this model, you can use one or more of these security services:

- Mutual authentication – the local server authenticates the remote server by retrieving the credential of the remote server and verifying it with the security mechanism. With this service, the credentials of both servers are authenticated and verified.
- Message confidentiality via encryption – messages are encrypted when sent to the remote server, and results from the remote server are encrypted.
- Message integrity – messages between the servers are checked for tampering.

Unified Login and the Remote Procedure Models

If the local server and remote server are set up to use security services, you can use unified login on both servers with **either** model, using one of these two methods:

- The System Security Officer defines a user as "trusted" with **sp_remoteoption** on the remote server. With this method, a security mechanism such as DCE authenticates the user and password. The user gains access to the local server via "unified login" and executes an RPC on the remote server. The user is trusted on the remote server and does not need to supply a password.
- A user specifies a password for the remote server when he or she connects to the local server. The facility to specify a remote server password is provided by the **ct_remote_pwd** routine available with Open Client Client-Library / C. For more information about this routine, see the *Open Client Client-Library/C Reference Manual*.

Establishing the Security Model for RPCs

To establish the security model for RPCs, use **sp_serveroption**. The syntax is:

```
sp_serveroption server, optname, [true | false]
```

To establish the security model, set *optname* to **rpc security model A** or **rpc security model B**. *server* names the remote server.

For example, to set model B for remote server TEST3, execute:

```
sp_serveroption test3, "rpc security model B", true
```

The default model is "A," that is, remote procedure calls are handled the same as in previous releases. No server options need to be set for model A.

Setting Server Options for RPC Security Model B

For RPC security model B, you can set options with the **sp_serveroption** system procedure. The syntax is:

```
sp_serveroption server, optname, optvalue
```

where:

- *server* is the name of the remote server.
- *optname* is the name of the option. Values can be:

  - **security mechanism** – the name of the security mechanism to use when running an RPC on a remote server.
  - **mutual authentication** – set this option to 1 to cause the local Adaptive Server to authenticate and verify the remote server. If this parameter is 0 (the default), the remote server still verifies the local server when it sends an RPC, but the local server does not check the validity of the remote server.
  - **use message confidentiality** – set this option to 1 to cause all messages for the RPCs to be encrypted when they are sent to the remote server and received from the remote server. If this parameter is 0 (the default), data for the RPCs will not be encrypted.
  - **use message integrity** – set this option to 1 to require that all RPC messages be checked for tampering. If this parameter is 0 (the default), RPC data will not be checked for tampering.

- *optvalue* must be equal to "true" or "false" for all values of *optname*, **except security mechanism**. If the option you are setting is **security mechanism**, specify the name of the security mechanism. To find the list of security mechanisms, execute:

  ```
  select * from syssecmechs
  ```

  For information about the *syssecmechs* system table, see "Determining Enabled Security Services" on page 10-31.

For example, to set up the local server to execute RPCs on a remote server, TEST3, which will use the "dce" security mechanism, and to use mutual authentication for all RPCs between the two servers, execute:

```
sp_serveroption TEST3, "security mechanism", dce
sp_serveroption TEST3, "mutual authentication",
     true
```

Rules for Setting Up Security Model B for RPCs

Follow these rules when setting up security model B for RPCs:

- Both servers must be using security model B.
- Both servers must be using the same security mechanism, and that security mechanism must support the security services set with **sp_serveroption**.
- The System Security Officer of the local server must specify any security services that are required by the remote server. For

example, if the remote server requires that all messages use the message confidentiality security service, the System Security Officer must use **sp_serveroption** to activate **use message confidentiality.**

- Logins who are authenticated by a security mechanism and log into Adaptive Server using "unified login" will not be permitted to execute RPCs on the remote procedure unless the logins are specified as "trusted" on the remote server or the login specifies the password for the remote server. Users, when they use Open Client Client-Library can use the routine **ct_remote_pwd** to specify a password for server-to-server connections. A System Administrator on Adaptive Server can use **sp_remoteoption** to specify that a user is trusted to use the remote server without specifying a password.

Preparing to Use Security Model B for RPCs

Table 10-7 provides steps for using security model B to establish security for RPCS.

Table 10-7: Process for using security model B for RPCs

Task, Who Performs It, and Where	Command, System Procedure, or Tool	See
System Administrator from the operating system: 1. Make sure the *interfaces* file or the Directory Service contains an entry for both servers and a secmech line listing the security mechanism.	UNIX: **dscp** or **dscp_dce** Desktop: **dsedit**	"Specifying Security Information for the Server" on page 10-10 For information about how to use **dscp** or **dscp_dce**, see *Open Client/Server Configuration Guide for UNIX*. For information about how to use **dsedit**, see the *Open Client/Server Configuration Guide for Desktop Platforms*.
System Security Officer on remote server: 2. Add the local server to *master..sysservers*.	**sp_addserver** Example: **sp_addserver "lcl_server"**	"Adding a Remote Server" on page 9-3. **sp_addserver** in the *Adaptive Server Reference Manual*.

Table 10-7: Process for using security model B for RPCs (continued)

Task, Who Performs It, and Where	Command, System Procedure, or Tool	See
System Security Officer on remote server: 3. Add logins to *master..syslogins.*	**sp_addlogin** Example: **sp_addlogin user1, "pwuser1"**	"Adding Logins to Adaptive Server" on page 6-3. **sp_addlogin** in the *Adaptive Server Reference Manual.*
System Security Officer on remote server: 4. Set **use security services** on, and set the **rpc security model B** as the model for connections with the local server.	**sp_configure** (to set **use security services**) **sp_serveroption** (to set the RPC security model) Example: **sp_configure "use security services", 1** **sp_serveroption lcl_server, "rpc security model B", true**	"Establishing the Security Model for RPCs" on page 10-21. "Enabling Network-Based Security" on page 10-13. "use security services (Windows NT Only)" in Chapter 17, "Setting Configuration Parameters" in the *System Administration Guide.* **sp_configure** in the *Adaptive Server Reference Manual.* **sp_serveroption** in the *Adaptive Server Reference Manual.*
System Administrator on remote server: 5. Optionally, specify certain users as "trusted" to log into the remote server from the local server without supplying a password.	**sp_remoteoption** Example: **sp_remoteoption lcl_server, user1, user1, trusted, true**	"Password Checking for Remote Users" on page 9-12. **sp_remoteoption** in the *Adaptive Server Reference Manual.*
System Security Officer on local server: 6. Add both the local server and the remote server to *master..sysservers.*	**sp_addserver** Example: **sp_addserver lcl_server, local** **sp_addserver rem_server**	"Adding a Remote Server" on page 9-3. **sp_addserver** in the *Adaptive Server Reference Manual.*
System Security Officer on local server: 7. Add logins to *master..logins.*	**sp_addlogin** Example: **sp_addlogin user1, "pwuser1"**	"Adding Logins to Adaptive Server" on page 6-3. **sp_addlogin** in the *Adaptive Server Reference Manual.*

Table 10-7: Process for using security model B for RPCs (continued)

Task, Who Performs It, and Where	Command, System Procedure, or Tool	See
System Security Officer on local server: 8. Set **use security services** on, and set the **rpc security model B** as the model for connections with the remote server.	**sp_configure** (to set **use security services**) **sp_serveroption** (to set the RPC security model) Example: **sp_configure "use security services", 1** **sp_serveroption rem_server, "rpc security model B", true**	"Establishing the Security Model for RPCs" on page 10-21. "Enabling Network-Based Security" on page 10-13. "use security services (Windows NT Only)" in Chapter 17, "Setting Configuration Parameters" in the *System Administration Guide* **sp_configure** in the *Adaptive Server Reference Manual*. **sp_serveroption** in the *Adaptive Server Reference Manual*.
System Security Officer on local server: 9. Specify the security mechanism and the security services to use for connections with the remote server.	**sp_serveroption** Example: **sp_serveroption rem_server, "security mechanism", dce** **sp_serveroption rem_server, "use message integrity", true**	"Setting Server Connection Options" on page 9-5. **sp_serveroption** in the *Adaptive Server Reference Manual*.

Example of Setting Up Security Model B for RPCs

Assume that:

- A local server, *lcl_serv*, will run RPCs on a remote server, *rem_serv*.
- Both servers will use security model B and the DCE security service.
- These RPC security services will be in effect: mutual authentication and message integrity.
- Users "user1" and "user2" will use unified login to log in to the local server, *lcl_serv*, and run RPCs on *rem_serv*. These users will be "trusted" on *rem_serv* and will not need to specify a password for the remote server.

- User “user3” will not use unified login, will not be trusted, and must supply a password to Adaptive Server when logging in.

You would use the following sequence of commands to set up security for RPCs between the servers:

System Security Officer on remote server (rem_serv):

```
sp_addserver 'lcl_serv'
sp_addlogin user1, "eracg12"
sp_addlogin user2, "esirpret"
sp_addlogin user3, "drabmok"
sp_configure "use security services", 1
sp_serveroption lcl_serv, "rpc security model B",
 true
sp_serveroption lcl_serv, "security mechanism", dce
```

System Administrator on remote server (rem_serv):

```
sp_remoteoption lcl_serv, user1, user1, trusted,
 true
sp_remoteoption lcl_serv, user2, user2, trusted,
 true
```

System Security Officer on local server (lcl_serv):

```
sp_addserver lcl_serv, local
sp_addserver rem_serv
sp_addlogin user1, "eracg12"
sp_addlogin user2, "esirpret"
sp_addlogin user3, "drabmo1"
sp_configure "use security services", 1
sp_configure rem_serv, "rpc security model B", true
sp_serveroption rem_serv, "security mechanism", dce
sp_serveroption rem_serv, "mutual authentication"
 true
sp_serveroption rem_serv, "use message integrity"
 true
```

In addition, the *interfaces* file or Directory Service must have entries for *rem_serv* and *lcl_serv*. Each entry should specify the “dce” security service. For example, you might have these *interfaces* entries, as created by the **dscp** utility:

```
## lcl_serv (3201)
lcl_serv
master tli tcp /dev/tcp \x00020c8182d6551100000000000000000
query tli tcp /dev/tcp \x00020c8182d6551100000000000000000
secmech 1.3.6.1.4.1.897.4.6.1
## rem_serv (3519)
rem_serv
master tli tcp /dev/tcp \x000214ad82d6551100000000000000000
query tli tcp /dev/tcp \x000214ad82d6551100000000000000000
secmech 1.3.6.1.4.1.897.4.6.1
```

➤ ***Note***

To actually use the security services on either server, you must reboot the server so that the static parameter, **use security services**, takes effect.

For detailed information about setting up servers for remote procedure calls, see Chapter 9, "Managing Remote Servers."

Getting Information About Remote Servers

The system procedure **sp_helpserver** displays information about servers. When it is used without an argument, it provides information about all the servers listed in *sysservers*. You can specify a particular server to receive information about that server. The syntax is:

```
sp_helpserver [server]
```

For example, to display information about the GATEWAY server, execute:

```
sp_helpserver GATEWAY
```

Connecting to the Server and Using the Security Services

The **isql** and **bcp** utilities include the following command line options to enable network-based security services on the connection:

-K *keytab_file*
-R *remote_server_principal*
-V *security_options*
-Z *security_mechanism*

➤ ***Note***

Versions of **isql** and **bcp** for the DCE Directory Service and for DCE security services are available. They are **isql_dce** and **bcp_dce**. You must use these versions when you are using DCE.

These options are described in the following paragraphs.

-K *keytab_file* can be used only with DCE security. It specifies a DCE keytab file that contains the security key for the user logging into the server. Keytab files can be created with the DCE **dcecp** utility—see your DCE documentation for more information.

If the **-K** option is not supplied, the user of **isql** must be logged into DCE. If the user specifies the **-U** option, the name specified with **-U** must match the name defined for the user in DCE.

-R *remote_server_principal* specifies the principal name for the server as defined to the security mechanism. By default, a server's principal name matches the server's network name (which is specified with the **-S** option or the DSQUERY environment variable). The **-R** option must be used when the server's principal name and network name are not the same.

-V *security_options* specifies network-based user authentication. With this option, the user must log into the network's security system before running the utility. In this case, if a user specifies the **-U** option, the user must supply the network user name known to the security mechanism; any password supplied with the **-P** option is ignored.

-V can be followed by a *security_options* string of key-letter options to enable additional security services. These key letters are:

c – enable data confidentiality service

i – enable data integrity service

m – enable mutual authentication for connection establishment

o – enable data origin stamping service

r – enable data replay detection

q – enable out-of-sequence detection

-Z *security_mechanism* – specifies the name of a security mechanism to use on the connection.

Security mechanism names are defined in the *libtcl.cfg* configuration file. If no *security_mechanism* name is supplied, the default mechanism is used. For more information about security mechanism names, see the *Open Client/Server Configuration Guide* for your platform.

If you log in to the security mechanism and then log in to Adaptive Server, you do not need to specify the **-U** option on the utility because Adaptive Server gets the user name from the security mechanism. For example, consider the following session:

```
svrsole4% dce_login user2
Enter Password:
svrsole4% $SYBASE/bin/isql_dce -V
1> select suser_name()
2> go

------------------------------
user2
```

For this example, "user2" logs in to DCE with **dce_login** and then logs into Adaptive Server without specifying the **-U** option. The **-V** option without parameters implicitly specifies one security service: unified login.

For more information about Adaptive Server utilities, see the *Utility Programs* manual for your platform.

If you are using Client-Library to connect to Adaptive Server, you can define security properties before connecting to the server. For example, to check message sequencing, set the CS_SEC_DETECTSEQ property. For information about using security services with Client-Library, see the *Open Client Client-Library/C Reference Manual.*

Example of Using Security Services

Assume that your login is "mary" and you want to use the DCE security mechanism with unified login (always in effect when you specify the **-V** option of **isql_dce** or **bcp_dce**), message confidentiality, and mutual authentication for remote procedures. You want to connect to server WOND and run remote procedures on GATEWAY with mutual authentication. Assuming that a System Security Officer has set up both WOND and GATEWAY for **rpc Model B**, added you as a user on both servers, and defined you as a remote, "trusted" user on GATEWAY, you can use the following process:

1. Log in to the DCE security mechanism and receive a credential:

   ```
   dce_login mary
   ```

2. Log in to the Adaptive Server with **isql_dce:**

   ```
   isql_dce -SWOND -Vcm
   ```

3. Run:

   ```
   GATEWAY...sp_who
   GATEWAY...mary_prc1
   GATEWAY...mary_prc2
   ```

Now, all messages that Mary sends to the server and receives from the server will be encrypted (message confidentiality), and when she runs remote procedures, both the WOND and GATEWAY servers will be authenticated.

Using Security Mechanisms for the Client

Adaptive Server, when it is booted, determines the set of security mechanisms it supports. (See "Determining Security Mechanisms to Support" on page 10-18. From the list of security mechanisms that Adaptive Server supports, it must choose the one to be used for a particular client.

If the client specifies a security mechanism (for example with the **-Z** option of **isql_dce**), Adaptive Server uses that security mechanism. Otherwise, it uses the first security mechanism listed in the *libtcl.cfg* file.

Getting Information About Available Security Services

Adaptive Server enables you to:

- Determine what security mechanisms and services are supported by Adaptive Server
- Determine what security services are active for the current session
- Determine whether a particular security service is enabled for the session

Determining Supported Security Services and Mechanisms

A system table, *syssecmechs*, provides information about the security mechanisms and security services supported by Adaptive Server. The table, which is dynamically built when you query it, contains these columns:

- *sec_mech_name* is the name of the security mechanism; for example, the security mechanism might be "dce" or "NT LANMANAGER."
- *available_service* is the name of a security service supported by the security mechanism; for example, the security service might be "unified login."

Several rows may be in the table for a single security mechanism: one row for each security service supported by the mechanism.

To list all the security mechanisms and services supported by Adaptive Server, run this query:

```
select * from syssecmechs
```

```
The result might look something like:
sec_mech_name                 available_service
------------------------------ --------------------
 dce                            unifiedlogin
 dce                            mutualauth
 dce                            delegation
 dce                            integrity
 dce                            confidentiality
 dce                            detectreplay
 dce                             detectseq
```

Determining Enabled Security Services

To determine which security services are enabled for the current session, use the function **show_sec_services**. For example:

```
show_sec_services()
```

```
-----------------------------------------------------------------

          unifiedlogin mutualauth confidentiality

(1 row affected)
```

Determining Whether a Security Service Is Enabled

To determine whether a particular security service, such as "mutualauth" is enabled, use the function **is_sec_service_on**. The syntax is:

is_sec_service_on(*security_service_nm*)

where *security_service_nm* is a security service that is available. Use the name that is displayed when you query *syssecmechs*.

For example, to determine whether "mutualauth" is enabled, execute:

```
select is_sec_service_on("mutualauth")

-----------
          1

(1 row affected)
```

A result of 1 indicates the security service is enabled for the session. A result of 0 indicates the service is not in use.

Managing Physical Resources

11 Overview of Disk Resource Issues

This chapter discusses some basic issues that determine how you allocate and use disk resources with Adaptive Server. It covers the following topics:

Many Adaptive Server defaults are set to reasonable values for aspects of storage management, such as where databases, tables, and indexes are placed and how much space is allocated for each one. Responsibility for storage allocation and management is often centralized, and usually, the System Administrator has ultimate control over the allocation of disk resources to Adaptive Server and the physical placement of databases, tables, and indexes on those resources.

Device Allocation and Object Placement

When configuring a new system, the System Administrator must consider several issues that have a direct impact on the number and size of disk resources required. These device allocation issues refer to commands and procedures that add disk resources to Adaptive Server. Device allocation topics are described in the chapters shown in Table 11-1.

Table 11-1: Device allocation topics

Task	Chapter
Initialize and allocate a default pool of database devices.	Chapter 12, “Initializing Database Devices”
Mirror database devices for recovery.	Chapter 13, “Mirroring Database Devices”

After the initial disk resources have been allocated to Adaptive Server, the System Administrator, Database Owner, and object

owners should consider how to place databases and database objects on specific database devices. These object placement issues determine where database objects reside on your system and whether or not the objects share devices. Object placement tasks are discussed throughout this manual, including the chapters shown in Table 11-2.

Table 11-2: Object placement topics

Task	Chapter
Place databases on specific database devices.	Chapter 21, "Creating and Managing User Databases"
Place tables and indexes on specific database devices.	Chapter 23, "Creating and Using Segments"

Do not consider allocating devices separately from object placement. For example, if you decide that a particular table must reside on a dedicated pair of devices, you must first allocate those devices to Adaptive Server. The remaining sections in this chapter provide an overview that spans both device allocation and object placement issues, providing pointers to chapters where appropriate.

Commands for Managing Disk Resources

Table 11-3 lists the major commands a System Administrator uses to allocate disk resources to Adaptive Server and provides references to the chapters that discuss those commands.

Table 11-3: Commands for allocating disk resources

Command	Task	Chapter
disk init **name = "***dev_name***"** **physname = "***phys_name***"...**	Makes a physical device available to a particular Adaptive Server. Assigns a database device name (*dev_name*) that is used to identify the device in other Adaptive Server commands.	Chapter 12, "Initializing Database Devices"
sp_deviceattr *logicalname, optname, optvalue*	Changes the *dsync* setting of an existing database device file	Chapter 12, "Initializing Database Devices"
sp_diskdefault "*dev_name***"...**	Adds *dev_name* to the general pool of default database space.	Chapter 12, "Initializing Database Devices"

Table 11-3: Commands for allocating disk resources (continued)

Command	Task	Chapter
disk mirror **name =** *"dev_name"* **mirror =** *"phys_name"*...	Mirrors a database device on a specific physical device.	Chapter 13, "Mirroring Database Devices"

Table 11-4 lists the commands used in object placement. For information about how object placement affects performance, see Chapter 33, "Controlling Physical Data Placement," in the *Performance and Tuning Guide*.

Table 11-4: Commands for placing objects on disk resources

Command	Task	Chapter
create database...on *dev_name* or **alter database...on** *dev_name*	Makes database devices available to a particular Adaptive Server database. The **log on** clause to **create database** places the database's logs on a particular database device.	Chapter 21, "Creating and Managing User Databases"
create database... or **alter database...**	When used without the **on *dev_name*** clause, these commands allocate space on the default database devices.	Chapter 21, "Creating and Managing User Databases"
sp_addsegment *seg_name*, *dbname*, *devname* and **sp_extendsegment** *seg_name*, *dbname*, *devname*	Creates a segment, a named collection of space, from the devices available to a particular database.	Chapter 23, "Creating and Using Segments"
create table...on *seg_name* or **create index...on** *seg_name*	Creates database objects, placing them on a specific segment of the database's assigned disk space.	Chapter 23, "Creating and Using Segments"
create table... or **create index...**	When used without **on *seg_name***, tables and indexes occupy the general pool of space allocated to the database (the default devices).	Chapter 23, "Creating and Using Segments"

Considerations in Storage Management Decisions

The System Administrator must make many decisions regarding the physical allocation of space to Adaptive Server databases. The major considerations in these choices are:

- **Recovery** – disk mirroring and maintaining logs on a separate physical device provide two mechanisms for full recovery in the event of physical disk crashes.
- **Performance** – for tables or databases where speed of disk reads and writes is crucial, properly placing database objects on physical devices yields performance improvements. Disk mirroring slows the speed of disk writes.

Recovery

Recovery is the key motivation for using several disk devices. Nonstop recovery can be accomplished by mirroring database devices. Full recovery can also be ensured by storing a database's log on a separate physical device.

Keeping Logs on a Separate Device

Unless a database device is mirrored, full recovery requires that a database's transaction log be stored on a different device from the actual data (including indexes) of a database. In the event of a hard disk crash, you can create an up-to-date database by loading a dump of the database and then applying the log records that were safely stored on another device. See Chapter 21, "Creating and Managing User Databases," for information about the **log on** clause of **create database**.

Mirroring

Nonstop recovery in the event of a hard disk crash is guaranteed by of mirroring all Adaptive Server devices to a separate physical disk. Chapter 13, "Mirroring Database Devices," describes the process of mirroring devices.

Performance

You can improve system performance by placing logs and database objects on separate devices:

- Placing a table on one hard disk and nonclustered indexes on another ensures that physical reads and writes are faster, since the work is split between two disk drives.

- Splitting large tables across two disks can improve performance, particularly for multi-user applications.
- When log and data share devices, user log cache buffering of transaction log records is disabled.
- Partitioning provides multiple insertion points for a heap table, adds a degree of parallelism to systems configured to perform parallel query processing, and makes it possible to distribute a table's I/O across multiple database devices.

See Chapter 33, "Controlling Physical Data Placement," in the *Performance and Tuning Guide* for a detailed discussion of how object placement affects performance.

Status and Defaults at Installation Time

You can find instructions for installing Adaptive Server in the installation documentation for your platform. The installation program and scripts initialize the master device and set up the *master*, *model*, *sybsystemprocs*, *sybsecurity*, and temporary databases for you.

When you install Adaptive Server, the system databases, system defined segments, and database devices are organized as follows:

- The *master*, *model*, and *tempdb* databases are installed on the master device.
- The *sybsystemprocs* database is installed on a device that you specified.
- Three segments are created in each database: *system*, *default*, and *logsegment*.
- The master device is the default storage device for all user-created databases.

➤ ***Note***

After initializing new devices for default storage, remove the master device from the default storage area with **sp_diskdefault**. Do not store user databases and objects on the master device. See "Designating Default Devices" on page 12-9 for more information.

- If you install the audit database, *sybsecurity*, it is located on its own device.

System Tables That Manage Storage

Two system tables in the *master* database and two more in each user database track the placement of databases, tables (including the transaction log table, *syslogs*), and indexes. The relationship between the tables is illustrated in Figure 11-1.

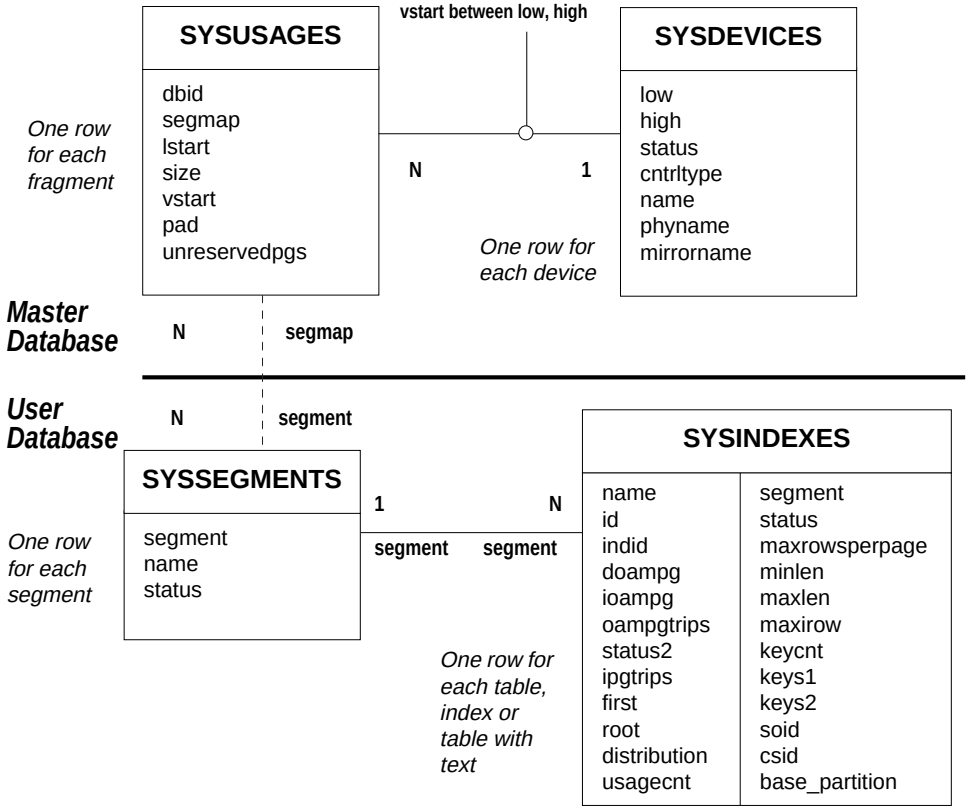

Figure 11-1: System tables that manage storage

The *sysdevices* Table

The *sysdevices* table in the *master* database contains one row for each **database device** and may contain a row for each dump device (tape, disk, or operating system file) available to Adaptive Server.

The **disk init** command adds entries for database devices to *master..sysdevices*. Dump devices, added with the system procedure **sp_addumpdevice**, are discussed in Chapter 26, "Developing a Backup and Recovery Plan."

sysdevices stores two names for each device:

- A **logical name** or **device name**, used in all subsequent storage-management commands, is stored in the *name* column of *sysdevices*. This is usually a user-friendly name, perhaps indicating the planned use for the device, for example "logdev" or "userdbdev."
- The **physical name** is the actual operating system name of the device. You use this name only in the **disk init** command; after that, all Adaptive Server data storage commands use the logical name.

You place a database or transaction log on one or more devices by specifying the logical name of the device in the **create database** or **alter database** statement. The **log on** clause to **create database** places a database's transaction log on a separate device to ensure full recoverability. The log device must also have an entry in *sysdevices* before you can use **log on**.

A database can reside on one or more devices, and a device can store one or more databases. See Chapter 21, "Creating and Managing User Databases," for information about creating databases on specific database devices.

The *sysusages* Table

The *sysusages* table in the *master* database keeps track of all of the space that you assign to all Adaptive Server databases.

create database and **alter database** allocate new space to the database by adding a row to *sysusages* for each database device or device fragment. When you allocate only a portion of the space on a device with **create** or **alter database**, that portion is called a **fragment**.

The system procedures **sp_addsegment**, **sp_dropsegment**, and **sp_extendsegment** change the *segmap* column in *sysusages* for the device that is mapped or unmapped to a segment. Chapter 23, "Creating and Using Segments," discusses these procedures in detail.

The *syssegments* Table

The *syssegments* table, one in each database, lists the segments in a database. A **segment** is a collection of the database devices and/or fragments available to a particular database. Tables and indexes can be assigned to a particular segment, and therefore to a particular physical device, or can span a set of physical devices.

create database makes default entries in *syssegments*. The system procedures **sp_addsegment** and **sp_dropsegment** add and remove entries from *syssegments*.

The *sysindexes* Table

The *sysindexes* table lists each table and index and the segment where each table, clustered index, nonclustered index, and chain of text pages is stored. It also lists other information such as the **max_rows_per_page** setting for the table or index.

The **create table**, **create index**, and **alter table** commands create new rows in *sysindexes*. Partitioning a table changes the function of *sysindexes* entries for the table, as described in Chapter 33, "Controlling Physical Data Placement," in the *Performance and Tuning Guide*.

12 Initializing Database Devices

This chapter explains how to initialize database devices and how to assign devices to the default pool of devices. Topics include:

What Are Database Devices?

A database device stores the objects that make up databases. The term **device** does not necessarily refer to a distinct physical device: it can refer to any piece of a disk (such as a disk partition) or a file in the file system that is used to store databases and their objects.

Each database device or file must be prepared and made known to Adaptive Server before it can be used for database storage. This process is called **initialization**.

After a database device has been initialized, it can be:

- Allocated to the default pool of devices for the **create** and **alter database** commands
- Assigned to the pool of space available to a user database
- Assigned to a user database and used to store one or more database objects
- Assigned to store a database's transaction logs

Using the *disk init* Command

A System Administrator initializes new database devices with the **disk init** command, which:

- Maps the specified physical disk device or operating system file to a **database device** name
- Lists the new device in *master..sysdevices*

- Prepares the device for database storage

➤ ***Note***

Before you run **disk init**, see the installation documentation for your platform for information about choosing a database device and preparing it for use with Adaptive Server. You may want to repartition the disks on your computer to provide maximum performance for your Sybase databases.

disk init divides the database devices into **allocation units** of 256 2K pages, a total of 1/2MB. In each 256-page allocation unit, the **disk init** command initializes the first page as the allocation page, which will contain information about the database (if any) that resides on the allocation unit.

◆ ***WARNING!***

After you run the disk init command, dump the *master* database. This makes recovery easier and safer in case *master* is damaged. See Chapter 28, "Restoring the System Databases."

disk init Syntax

The syntax of **disk init** is:

```
disk init
   name = "device_name" ,
   physname = "physicalname" ,
   vdevno = virtual_device_number ,
   size = number_of_blocks
   [, vstart = virtual_address ,
        cntrltype = controller_number]
   [, contiguous] (OpenVMS only)
   [, dsync = {true | false}]
```

disk init Examples

On UNIX:

```
disk init
  name = "user_disk",
  physname = "/dev/rxy1a",
  vdevno = 2, size = 5120
```

On OpenVMS:

```
disk init
 name = "user_disk",
 physname = "disk$rose_1:[dbs]user.dbs",
 vdevno = 2, size = 5120,
 contiguous
```

On Windows NT:

```
disk init
  name = "user_disk",
  physname = "d:\devices\userdisk.dat",
  vdevno = 2, size = 5120
```

Specifying a Logical Device Name with *disk init*

The *device_name* must be a valid identifier. This name is used in the **create database** and **alter database** commands, and in the system procedures that manage segments. The logical device name is known only to Adaptive Server, not to the operating system on which the server runs.

Specifying a Physical Device Name with *disk init*

The *physicalname* of the database device gives the name of a raw disk partition (UNIX) or foreign device (OpenVMS) or the name of an operating system file. On PC platforms, you typically use operating system file names for *physicalname*.

Choosing a Device Number for *disk init*

vdevno is an identifying number for the database device. It must be unique among the devices used by Adaptive Server. Device number 0 represents the master device. Legal numbers are between 1 and 255, but the highest number must be one less than the number of database devices for which your system is configured. For example,

for a system with a default configuration of 10 devices, the legal device numbers are 1–9. To see the configuration value for your system, execute **sp_configure "number of devices"** and check the run value:

```
sp_configure "number of devices"
Parameter name  Default  Memory Used  Config Value  Run Value
--------------- -------  -----------  ------------  ----------
number of devices    10           0            10          10
```

To see the numbers already in use for **vdevno**, look in the *device_number* column of the report from **sp_helpdevice**, or use the following query to list all the device numbers currently in use:

```
select distinct low/16777216
    from sysdevices
    order by low
```

Adaptive Server is originally configured for 10 devices. You may be limited to a smaller number of devices by operating system constraints. See the discussion of **sp_configure**, which is used to change configuration parameters, in Chapter 17, "Setting Configuration Parameters."

Specifying the Device Size with *disk init*

The **size** of the database device must be given in 2K blocks. There are 512 2K blocks in 1MB. The maximum size of a database device is system-dependent.

➤ ***Note***

You cannot alter the size of a database device after running **disk init**.

If you are planning to use the new device for the creation of a new database, the minimum **size** is the larger of:

- The size of *model*. When you install Adaptive Server, *model* uses 1024 2K blocks (2MB). Use **sp_helpdb model** to see the current size of *model*.
- The configuration parameter **default database size**. Use **sp_configure** and look at the run value for **default database size.**

If you are initializing a database device for a transaction log or for storing small tables or indexes on a segment, the **size** can be as small as 512 2K blocks (1MB).

If you are initializing a raw device (UNIX) or a foreign device (OpenVMS), determine the size of the device from your operating system, as described in the the installation documentation for your platform. Use the total size available, up to the maximum for your platform. After you have initialized the disk for use by Adaptive Server, you cannot use any space on the disk for any other purpose.

disk init uses **size** to compute the value for the high virtual page number in *sysdevices.high*.

◆ ***WARNING!***

If the physical device does not contain the number of blocks specified by the size parameter, the disk init command fails. If you use the optional vstart parameter, the physical device must contain the sum of the blocks specified by both the vstart and size parameters, or the command fails.

Specifying the *dsync* setting with *disk init* (optional)

For devices initialized on UNIX operating system files, the **dsync** setting controls whether or not writes to those files are buffered. When the **dsync** setting is on, Adaptive Server opens a database device file using the UNIX **dsync** flag. The **dsync** flag ensures that writes to the device file occur directly on the physical storage media, and Adaptive Server can recover data on the device in the event of a system failure.

When **dsync** is off, writes to the device file may be buffered by the UNIX file system, and the recovery of data on the device cannot be ensured. The **dsync** setting should be turned off only when data integrity is not required, or when the System Administrator requires performance and behavior similar to earlier Adaptive Server versions.

➤ ***Note***

The **dsync** setting is ignored for devices initialized on raw partitions, and for devices initialized on Windows NT files. In both cases, writes to the database device take place directly to the physical media.

Performance Implications of *dsync*

The use of the **dsync** setting with database device files incurs the following performance trade-offs:

- HP-UX and Digital UNIX do not support asynchronous I/O on operating system files. If database device files on these platforms use the **dsync** option, then the Adaptive Server engine writing to the device file will block until the write operation completes. This can cause poor performance during update operations.
- When **dsync** is on, write operations to database device files may be slower compared to previous versions of Adaptive Server (where **dsync** is not supported). This is because Adaptive Server must write data to disk instead of simply copying cached data to the UNIX file system buffer.

  In cases where highest write performance is required (but data integrity after a system failure is not required) turning **dsync** off yields device file performance similar to earlier Adaptive Server versions. For example, you may consider storing *tempdb* on a dedicated device file with **dsync** disabled, if performance is not acceptable while using **dsync**.
- Response time for read operations is generally better for devices stored on UNIX operating system files as compared to devices stored on raw partitions. Data from device files can benefit from the UNIX file system cache as well as the Adaptive Server cache, and more reads may take place without requiring physical disk access.
- The **disk init** command takes longer to complete with previous Adaptive Server versions, because the required disk space is allocated during device initialization.

Limitations and Restrictions of *dsync*

The following limitations and restrictions apply to using the **dsync** setting:

- **dsync** is always set to "true" for the master device file. You cannot change the **dsync** setting for the master device. If you attempt to turn **dsync** off for the master device, Adaptive Server displays a warning message.
- If you change a device file's **dsync** setting using the **sp_deviceattr** procedure, you must reboot Adaptive Server before the change takes affect.

- When you upgrade from an Adaptive Server prior to version 12.x, **dsync** is set to "true" for the master device file only. You must use the **sp_deviceattr** procedure to change the **dsync** setting for any other device files.
- Adaptive Server ignores the **dsync** setting for database devices stored on raw partitions. Writes to devices stored on raw partitions are always done directly to the physical media.
- Adaptive Server also ignores the **dsync** setting for database devices stored on Windows NT operating system files. Adaptive Server on Windows NT automatically uses a capability similar to **dsync** for all database device files.

Other Optional Parameters for *disk init*

vstart is the starting virtual address, or the offset in 2K blocks, for Adaptive Server to begin using the database device. The default value (and usually the preferred value) of **vstart** is 0. If the specified device does not have the sum of **vstart** + **size** blocks available, the **disk init** command fails.

The optional **cntrltype** keyword specifies the disk controller. Its default value is 0. Reset it only if instructed to do so.

contiguous, an option for OpenVMS systems only, forces the database file to be created contiguously.

➤ ***Note***

To perform disk initialization, the user who started Adaptive Server must have the appropriate operating system permissions on the device that is being initialized.

Getting Information About Devices

The system procedure **sp_helpdevice** provides information about the devices in the *sysdevices* table.

When used without a device name, **sp_helpdevice** lists all the devices available on Adaptive Server. When used with a device name, it lists information about that device. Here, **sp_helpdevice** is used to report information about the master device:

```
sp_helpdevice master
```

```
device_name  physical_name  description
-----------  -------------- ----------------------------------------
master       d_master       special, default disk, physical disk, 20 MB

status      cntrltype    device_number     low      high
------      ----------   --------------    ------   -------
3           0            0                 0        9999
```

Each row in *master..sysdevices* describes:

- A dump device (tape, disk, or file) to be used for backing up databases, or
- A database device to be used for database storage.

The initial contents of *sysdevices* are operating-system-dependent. Entries in *sysdevices* usually include:

- One for the master device
- One for the *sybsystemprocs* database, which you can use to store additional databases such as *pubs2* and *sybsyntax*, or for user databases and logs
- Two for tape dump devices

If you installed auditing, there will also be a separate device for *sybsecurity*.

The *low* and *high* fields represent the page numbers that have been assigned to the device. For dump devices, they represent the media capacity of the device.

The *status* field in *sysdevices* is a bitmap that indicates the type of device, whether a disk device will be used as a default storage device when users issue a **create** or **alter database** command without specifying a database device, disk mirroring information, and **dsync** settings. The status bits and their meanings are listed in Table 12-1:

Table 12-1: Status bits in sysdevices

Bit	Meaning
1	Default disk (may be used by any **create** or **alter database** command that does not specify a location)
2	Physical disk
4	Logical disk (not used)
8	Skip header (used with tape dump devices)
16	Dump device
32	Serial writes
64	Device mirrored
128	Reads mirrored
256	Secondary mirror side only
512	Mirror enabled

Table 12-1: Status bits in sysdevices (continued)

Bit	Meaning
2048	Used internally; set after **disk unmirror, side = retain**
4096	Primary device needs to be unmirrored (used internally)
8192	Secondary device needs to be unmirrored (used internally)
16384	UNIX file device uses dsync setting (writes occur directly to physical media)

For more information about dump devices and **sp_addumpdevice**, see Chapter 26, "Developing a Backup and Recovery Plan."

Dropping Devices

To drop database and dump devices, use **sp_dropdevice**. The syntax is:

```
sp_dropdevice logicalname
```

You cannot drop a device that is in use by a database. You must drop the database first.

sp_dropdevice removes the device name from *sysdevices*. **sp_dropdevice** does not remove an operating system file: it only makes the file inaccessible to Adaptive Server. You must use operating system commands to delete a file after using **sp_dropdevice**.

Designating Default Devices

To create a pool of default database devices to be used by all Adaptive Server users for creating databases, use **sp_diskdefault** after the devices are initialized. **sp_diskdefault** marks these devices in *sysdevices* as default devices. Whenever users create (or alter) databases without specifying a database device, new disk space is allocated from the pool of default disk space.

The syntax for **sp_diskdefault** is:

```
sp_diskdefault logicalname, {defaulton | defaultoff}
```

You are most likely to use the **defaultoff** option to remove the master device from the pool of default space:

```
sp_diskdefault master, defaultoff
```

The following command makes *sprocdev*, the device that holds the *sybsystemprocs* database, a default device:

```
sp_diskdefault sprocdev, defaulton
```

Adaptive Server can have multiple default devices. They are used in the order in which they appear in the *sysdevices* table (that is, alphabetical order). When the first default device is filled, the second default device is used, and so on.

➤ ***Note***

After initializing a set of database devices, you may want to assign them to specific databases or database objects rather than adding them to the default pool of devices. For example, you may want to make sure a table never grows beyond the size of a particular device.

Choosing Default and Nondefault Devices

sp_diskdefault lets you plan space usage carefully for performance and recovery, while allowing users to create or alter databases.

Make sure these devices are **not** default devices:

- The master device (use **sp_diskdefault** to set **defaultoff** after adding user devices)
- The device for *sybsecurity*
- Any device intended solely for logs
- Devices where high-performance databases reside, perhaps using segments

You can use the device that holds *sybsystemprocs* for other user databases.

➤ ***Note***

If you are using disk mirroring or segments, you should exercise caution in deciding which devices you add to the default list with **sp_diskdefault**. In most cases, devices that are to be mirrored or databases that will contain objects placed on segments should allocate devices specifically, rather than being made part of default storage.

13 Mirroring Database Devices

This chapter describes create and administer disk mirrors. Topics include:

What Is Disk Mirroring?

Disk mirroring can provide nonstop recovery in the event of media failure. The **disk mirror** command causes an Adaptive Server database device to be duplicated, that is, all writes to the device are copied to a separate physical device. If one device fails, the other contains an up-to-date copy of all transactions.

When a read or write to a mirrored device fails, Adaptive Server "unmirrors" the bad device and displays error messages. Adaptive Server continues to run unmirrored.

Deciding What to Mirror

When deciding to mirror a device, you must weigh such factors as the costs of system downtime, possible reduction in performance, and the cost of storage media. Reviewing these issues will help you decide what to mirror—just the transaction logs, all devices on a server, or selected devices.

➤ ***Note***

You cannot mirror a dump device.

You should mirror all default database devices so that you are protected if a **create** or **alter database** command affects a database device in the default list.

In addition to mirroring user database devices, you should always put their transaction logs on a separate database device. You can also mirror the database device used for transaction logs for even greater protection.

To put a database's transaction log (that is, the system table *syslogs*) on a different device than the one on which the rest of the database is stored, name the database device and the log device when you create the database. You can also use **alter database** to add a second device and then run the system procedure **sp_logdevice**.

Here are three examples that involve different cost and performance trade-offs:

1. **Speed of recovery** – you can achieve nonstop recovery when the *master* and user databases (including logs) are mirrored and can recover without the need to reload transaction logs.
2. **Storage space –** immediate recovery requires full redundancy (all databases and logs mirrored), which consumes disk space.
3. **Impact on performance** – Mirroring the user databases (as shown in Figure 13-2 and Figure 13-3) increases the time needed to write transactions to both disks.

Mirroring Using Minimal Physical Disk Space

Figure 13-1 illustrates the "minimum guaranteed configuration" for database recovery in case of hardware failure. The master device and a mirror of the user database transaction log are stored in separate partitions on one physical disk. The other disk stores the user database and its transaction log in two separate disk partitions.

If the disk with the user database fails, you can restore the user database on a new disk from your backups and the mirrored transaction log.

If the disk with the master device fails, you can restore the master device from a database dump of the *master* database and remirror the user database's transaction log.

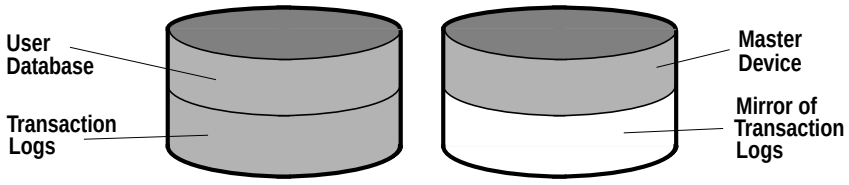

Figure 13-1: Disk mirroring using minimal physical disk space

This configuration minimizes the amount of disk storage required. It provides for full recovery, even if the disk storing the user database and transaction log is damaged, because the mirror of the transaction log ensures full recovery. However, this configuration does not provide nonstop recovery because the *master* and user databases are not being mirrored and must be recovered from backups.

Mirroring for Nonstop Recovery

Figure 13-2 represents another mirror configuration. In this case, the master device, user databases, and transaction log are all stored on different partitions of the same physical device and are all mirrored to a second physical device.

The configuration in Figure 13-2 provides nonstop recovery from hardware failure. Working copies of the *master* and user databases and log on the primary disk are all being mirrored, and failure of either disk will not interrupt Adaptive Server users.

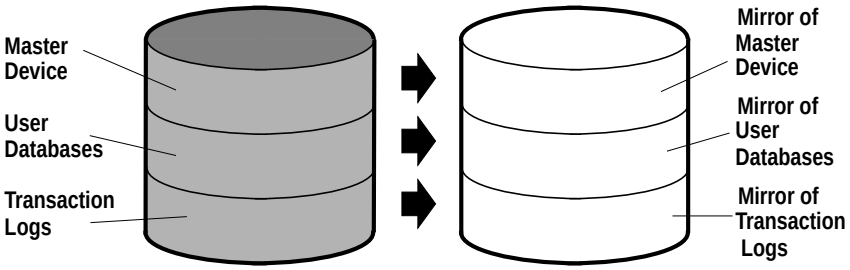

Figure 13-2: Disk mirroring for rapid recovery

With this configuration, all data is written twice, once to the primary disk and once to the mirror. Applications that involve many writes may be slower with disk mirroring than without mirroring.

Figure 13-3 illustrates another configuration with a high level of redundancy. In this configuration, all three database devices are mirrored, but the configuration uses four disks instead of two. This configuration speeds performance during write transactions because the database transaction log is stored on a different device from the user databases, and the system can access both with less disk head travel.

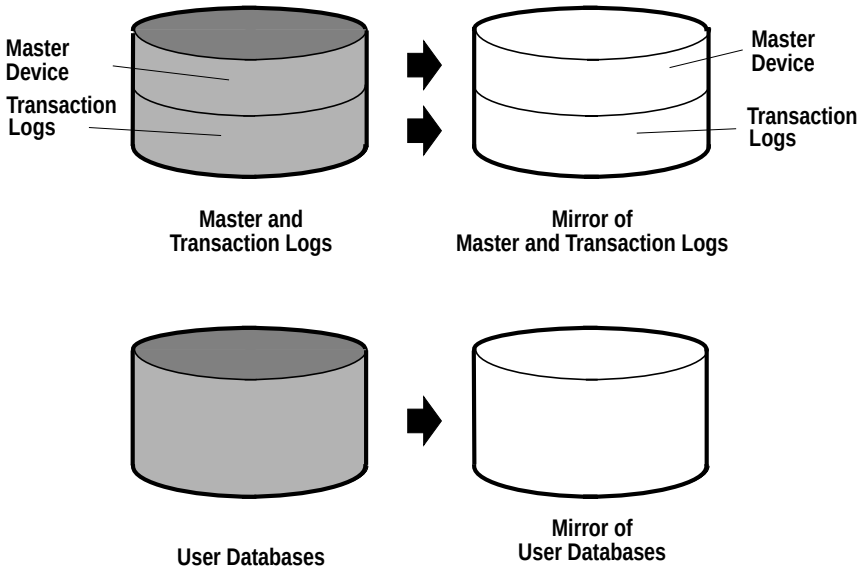

Figure 13-3: Disk mirroring: keeping transaction logs on a separate disk

Conditions That Do Not Disable Mirroring

Adaptive Server disables a mirror only when it encounters an I/O error on a mirrored device. For example, if Adaptive Server tries to write to a bad block on the disk, the resulting error disables mirroring for the device. However, processing continues without interruption on the unaffected mirror.

The following conditions **do not** disable a mirror:

- An unused block on a device is bad. Adaptive Server does not detect an I/O error and disables mirroring until it accesses the bad block.
- Data on a device is overwritten. This might happen if a mirrored device is mounted as a UNIX file system, and UNIX overwrites the Adaptive Server data. This causes database corruption, but mirroring is not disabled, since Adaptive Server would not encounter an I/O error.
- Incorrect data is written to both the primary and secondary devices.

- The file permissions on an active device are changed. Some System Administrators may try to test disk mirroring by changing permissions on one device, hoping to trigger I/O failure and unmirror the other device. But the UNIX operating system does not check permissions on a device after opening it, so the I/O failure does not occur until the next time the device is started.

Disk mirroring is not designed to detect or prevent database corruption. Some of the scenarios described can cause corruption, so you should regularly run consistency checks such as **dbcc checkalloc** and **dbcc checkdb** on all databases. See Chapter 25, "Checking Database Consistency," for a discussion of these commands.

Disk Mirroring Commands

The **disk mirror**, **disk unmirror**, and **disk remirror** commands control disk mirroring. All the commands can be issued while the devices are in use, so you can start or stop database device mirroring while databases are being used.

➤ ***Note***

The **disk mirror**, **disk unmirror**, and **disk remirror** commands alter the *sysdevices* table in the *master* database. After issuing any of these commands, you should dump the *master* database to ensure recovery in case *master* is damaged.

Initializing Mirrors

disk mirror starts disk mirroring. **Do not** initialize the mirror device with **disk init**. A database device and its mirror constitute one logical device. The **disk mirror** command adds the mirror name to the *mirrorname* column in the *sysdevices* table.

➤ ***Note***

To retain use of asynchronous I/O, always mirror devices that are capable of asynchronous I/O to other devices capable of asynchronous I/O. In most cases, this means mirroring raw devices to raw devices and operating system files to operating system files.

If the operating system cannot perform asynchronous I/O on files, mirroring a raw device to a regular file produces an error message. Mirroring a regular file to a raw device will work, but will not use asynchronous I/O.

Here is the **disk mirror** syntax:

```
disk mirror
   name = "device_name" ,
   mirror = "physicalname"
   [ , writes = { serial | noserial }]
   [ , contiguous ]      (OpenVMS only)
```

The *device_name* is the name of the device that you want to mirror, as it is recorded in *sysdevices.name* (by **disk init**). Use the **mirror =** "*physicalname*" clause to specify the path to the mirror device, enclosed in single or double quotes. If the mirror device is a file, "*physicalname*" must unambiguously identify the path where Adaptive Server will create the file; it cannot specify the name of an existing file.

On systems that support asynchronous I/O, the **writes** option allows you to specify whether writes to the first device must finish before writes to the second device begin (**serial**) or whether both I/O requests are to be queued immediately, one to each side of the mirror (**noserial**). In either case, if a write cannot be completed, the I/O error causes the bad device to become unmirrored.

serial writes are the default. The writes to the devices take place consecutively, that is, the first one finishes before the second one starts. **serial** writes provide protection in the case of power failures: one write may be garbled, but both of them will not be. **serial** writes are generally slower than **noserial** writes.

OpenVMS users should see the *Adaptive Server Reference Manual* for an explanation of the **contiguous** option.

In the following example, *tranlog* is the logical device name for a raw device. The *tranlog* device was initialized with **disk init** and is being used as a transaction log device (as in **create database...log on** *tranlog*). The following command mirrors the transaction log device:

```
disk mirror
  name = "tranlog",
  mirror = "/dev/rxy1e"
```

Unmirroring a Device

Disk mirroring is automatically deactivated when one of the two physical devices fails. When a read or write to a mirrored device is unsuccessful, Adaptive Server prints error messages. Adaptive Server continues to run, unmirrored. You must remirror the disk to restart mirroring.

Use the **disk unmirror** command to stop the mirroring process during hardware maintenance:

```
disk unmirror
     name = "device_name"
     [, side = { "primary" | secondary }]
     [, mode = { retain | remove }]
```

The **side** option to the **disk unmirror** command allows you to specify which side of the mirror to disable. **primary** (in quotes) is the device listed in the *name* column of *sysdevices*; **secondary** (no quotes required) is the device listed in the *mirrorname* column of *sysdevices*. **secondary** is the default.

The **mode** option indicates whether the unmirroring process should be temporary (**retain**) or permanent (**remove**). **retain** is the default.

Temporarily Deactivating a Device

By default (**mode**=**retain**), Adaptive Server temporarily deactivates the specified device; you can reactivate it later. This is similar to what happens when a device fails and Adaptive Server activates its mirror:

- I/O is directed only at the remaining device of the mirrored pair.
- The *status* column of *sysdevices* is altered to indicate that the mirroring feature has been deactivated.
- The entries for primary *(phyname)* and secondary *(mirrorname*) disks are unchanged.

Permanently Disabling a Mirror

Use **mode**=**remove** to disable disk mirroring. This option eliminates all references in the system tables to a mirror device, but does **not** remove an operating system file that has been used as a mirror.

If you set **mode**=**remove**:

- The *status* column is altered to indicate that the mirroring feature is to be ignored.
- The *phyname* column is replaced by the name of the secondary device in the *mirrorname* column if the primary device is the one being deactivated.
- The *mirrorname* column is set to NULL.

Effects on System Tables

The **mode** option changes the *status* column in *sysdevices* to indicate that mirroring has been disabled (see Table 12-1 on page 12-8). Its effects on the *phyname* and *mirrorname* columns in *sysdevices* depend on the **side** argument also, as shown in Table 13-1.

Table 13-1: Effects of mode and side options to the disk mirror command

		side	
		primary	**secondary**
mode	**remove**	Name in *mirrorname* moved to *phyname* and *mirrorname* set to null; *status* changed	Name in *mirrorname* removed; *status* changed
	retain	Names unchanged; *status* changed to indicate which device is being deactivated	

This example suspends the operation of the primary device:

```
disk unmirror
  name = "tranlog",
  side = primary
```

Restarting Mirrors

Use **disk remirror** to restart a mirror process that has been suspended due to a device failure or with **disk unmirror**. The syntax is:

```
disk remirror
      name = "device_name"
```

This command copies the database device to its mirror.

waitfor mirrorexit

Since disk failure can impair system security you can include, the **waitfor mirrorexit** command in an application to perform specific tasks when a disk becomes unmirrored:

```
begin
   waitfor mirrorexit
    commands to be executed
end
```

The commands depend on your applications. You may want to add certain warnings in applications that perform updates or use **sp_dboption** to make certain databases read-only if the disk becomes unmirrored.

➤ *Note*

Adaptive Server knows that a device has become unmirrored only when it attempts I/O to the mirror device. On mirrored databases, this occurs at a checkpoint or when the Adaptive Server buffer must be written to disk. On mirrored logs, I/O occurs when a process writes to the log, including any committed transaction that performs data modification, a checkpoint, or a database dump.

waitfor mirrorexit and the error messages that are printed to the console and error log on mirror failure are activated only by these events.

Mirroring the Master Device

If you choose to mirror the device that contains the *master* database, in a UNIX or Open VMS environment, you need to edit the runserver file for your Adaptive Server so that the mirror device starts when the server boots.

On UNIX, add the **-r** flag and the name of the mirror device:

```
dataserver -d /dev/rsd1f -r /dev/rs0e -e/sybase/install/errorlog
```

On OpenVMS, add the mirror name:

```
dataserver /device=(DUA0:[dbdevices]master.dat, -
     DUB1:[dbmirrors]mirror.dat) -
     /errorfile=sybase_system:[sybase.install]errorlog
```

For information about mirroring the master device on Windows NT, see the *Utility Programs* manual for your platform.

Getting Information About Devices and Mirrors

For a report on all Adaptive Server devices on your system (user database devices and their mirrors, as well as dump devices), execute **sp_helpdevice.**

Disk Mirroring Tutorial

The following steps illustrate the use of disk mirroring commands and their effect on selected columns of *master..sysdevices*:

Step 1

Initialize a new test device using:

```
disk init name = "test",
physname = "/usr/sybase/test.dat",
size=5120, vdevno=3
```

This inserts the following values into columns of *master..sysdevices*:

```
name  phyname               mirrorname   status
test  /usr/sybase/test.dat   NULL         2
```

Status 2 indicates that the device is a physical disk. Since the device mirrored bit (64) is off and the *mirrorname* column is null, this device is not mirrored.

Step 2

Mirror the test device using:

```
disk mirror name = "test",
mirror = "/usr/sybase/test.mir"
```

This changes the *master..sysdevices* columns to:

```
name  phyname               mirrorname            status
test  /usr/sybase/test.dat  /usr/sybase/test.mir  738
```

Status 738 indicates that mirroring is currently active (512) on this device. Reads are mirrored (128), and writes are mirrored (64) and serial (32). The device is a physical disk (2).

Step 3

Disable the mirror device (the secondary side), but retain that mirror:

```
disk unmirror name = "test",
side = secondary, mode = retain
```

```
name  phyname               mirrorname            status
test  /usr/sybase/test.dat  /usr/sybase/test.mir  2274
```

Status 2274 indicates that the mirror device has been retained (2048), but mirroring has been disabled (512 bit off), and only the primary device is used (256 bit off). Reads are mirrored (128), and writes are mirrored (64) and serial (32). The device is a physical disk (2).

Step 4

Remirror the test device:

```
disk remirror name = "test"
```

This resets the *master..sysdevices* columns to:

```
name  phyname               mirrorname            status
test  /usr/sybase/test.dat  /usr/sybase/test.mir  738
```

Status 738 indicates that mirroring is currently active (512) on this device. Reads are mirrored (128), and writes are mirrored (64) and serial (32). The device is a physical disk (2).

Step 5

Disable the test device (the primary side), but retain that mirror:

```
disk unmirror name = "test",
side = "primary", mode = retain
```

This changes the *master..sysdevices* columns to:

```
name  phyname               mirrorname           status
test  /usr/sybase/test.dat  /usr/sybase/test.mir 482
```

Status 482 indicates that mirroring has been disabled (512 bit off) and that only the secondary device is used (256). Reads are mirrored (128), and writes are mirrored (64) and serial (32). The device is a physical disk (2).

Step 6

Remirror the test device:

```
disk remirror name = "test"
```

This resets the *master..sysdevices* columns to:

```
name  phyname                mirrorname             status
test  /usr/sybase/test.dat   /usr/sybase/test.mir   738
```

Status 738 indicates that mirroring is currently active (512) on this device. Reads are mirrored (128), and writes are mirrored (64) and serial (32). The device is a physical disk (2).

Step 7

Disable the test device (the primary side), and remove that mirror:

```
disk unmirror name = "test", side = "primary",
mode = remove
```

This changes the *master..sysdevices* columns to:

```
name  phyname                mirrorname             status
test  /usr/sybase/test.mir   NULL                   2
```

Status 2 indicates that the device is a physical device. Since the *mirrorname* column is null, mirroring is not enabled on this device.

Step 8

Remove the test device to complete the tutorial:

```
sp_dropdevice test
```

This removes all entries for the test device from *master..sysdevices*.

14 Configuring Memory

This chapter describes how Adaptive Server uses memory and explains how to maximize the memory available to Adaptive Server on your system. Topics include:

Maximizing Adaptive Server Memory

The more memory that is available, the more resources Adaptive Server has for internal buffers and caches. Having enough memory available for caches reduces the number of times Adaptive Server has to read data or procedure plans from disk.

There is no performance penalty for configuring Adaptive Server to use the maximum amount of memory available on your computer. However, be sure to assess the other memory needs on your system first, and then configure the Adaptive Server to use only the remaining memory that is still available. Adaptive Server may not be able to start if it cannot acquire the memory for which it is configured.

To determine the maximum amount of memory available on your system for Adaptive Server:

1. Determine the total amount of physical memory on your computer system.
2. Subtract the memory required for the operating system from the total physical memory.
3. Subtract the memory required for Backup Server, Monitor Server, or other Adaptive Server-related software that must run on the same machine.
4. If the machine is not dedicated to Adaptive Server, also subtract the memory requirements for other system uses.

   For example, subtract the memory that will be used by any client applications that will run on the Adaptive Server machine.

Windowing systems, such as X Windows, require a lot of memory and can interfere with Adaptive Server performance when used on the same machine as Adaptive Server.

5. Subtract any memory that you want to allocate for the **additional network memory** configuration parameter. This is explained in "additional network memory" on page 17-107.

The memory left over after subtracting requirements for the operating system, other applications, and **additional network memory** is the total memory available for Adaptive Server. Configure Adaptive Server to use this memory by setting the **total memory** parameter to that value. See "total memory" on page 17-110 for details on setting **total memory** and other configuration parameters.

Consider changing the value of the **total memory** configuration parameter:

- When you change the amount of RAM on your machine
- When the pattern of use of your machine changes
- If you allocate memory for **additional network memory** for Adaptive Server

If Adaptive Server Cannot Start

When Adaptive Server starts, it must acquire the full amount of memory set by **total memory** from the operating system. If Adaptive Server cannot start for this reason, reduce the memory requirements for Adaptive Server by editing the value of the **total memory** parameter in the server's configuration file. You may also need to reduce the values for other configuration parameters that require large amounts of memory. Then restart Adaptive Server so that it will use the new values. See Chapter 17, "Setting Configuration Parameters," for information about using configuration files.

How Adaptive Server Uses Memory

The value of the **total memory** parameter specifies the total amount of memory that Adaptive Server requires at start-up. For example, if the **total memory** parameter has a value of 50,000 pages, Adaptive Server tries to obtain 97.65MB (50,000 * 2048) of memory at start-up. If this amount is not available, Adaptive Server will not start.

When Adaptive Server starts, it allocates memory for:

- Adaptive Server executable code

- Memory used by Adaptive Server for nonconfigurable data structures
- Memory for user-configurable parameters

Adaptive Server then divides the remaining memory between the data cache and the procedure cache, based on the value of the **procedure cache percent** parameter. Figure 14-1 illustrates how Adaptive Server allocates memory.

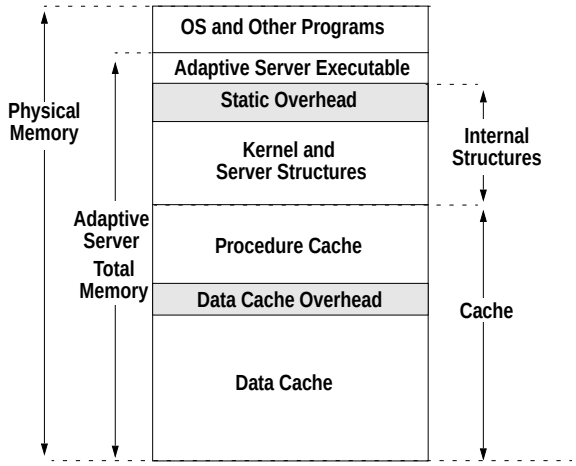

Figure 14-1: Example of memory allocation

When you configure Adaptive Server parameters that require memory, the amount of memory available to the procedure and data cache pools is reduced. Figure 14-2 shows how configuring the **number of worker processes** reduces the memory available to the procedure and data cache pools.

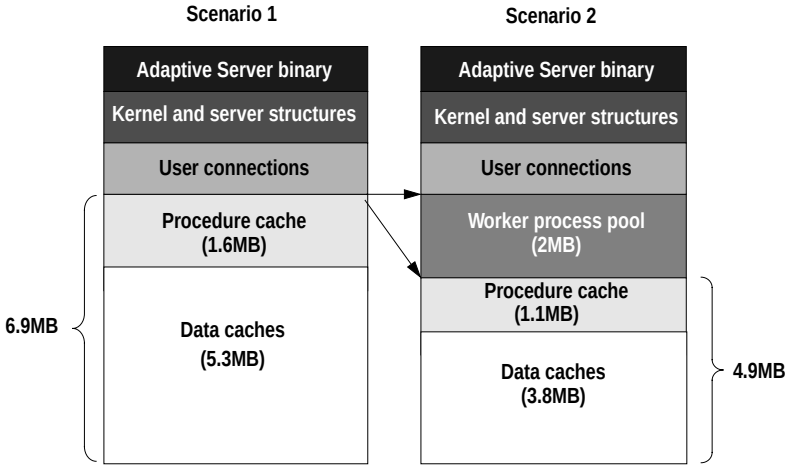

Figure 14-2: How changing configuration parameters reduces cache size

The size of the data and procedure caches has a significant impact on overall performance. On a development system, you may want to increase the amount of memory dedicated to the procedure cache. On a production system, however, you may want to reduce the size of the procedure cache to provide more memory for the data cache. See Chapter 32, "Memory Use and Performance," in the *Performance and Tuning Guide* for recommendations on optimizing procedure cache size.

To determine the amount of memory available for caches, you can estimate the amount of overhead required for Adaptive Server and subtract that amount from the **total memory.** Or you can compute the size of the caches using start-up messages from the error log file.

System Procedures for Configuring Memory

The three system procedures that you need to use while configuring Adaptive Server memory are:

- **sp_configure**
- **sp_helpconfig**
- **sp_monitorconfig**

Using *sp_configure* to Set Configuration Parameters

The full syntax and usage of **sp_configure** and details on each configuration parameter are covered in Chapter 17, "Setting Configuration Parameters." The rest of this chapter discusses issues pertinent to configuring the parameters that use Adaptive Server memory.

Execute **sp_configure**, specifying "Memory Use" to see these parameter settings on your server.

```
sp_configure "Memory Use"
```

Parameter Name	Default	Memory Used	Config Value	Run Value
additional network memory	0	48	49152	49152
allow resource limits	0	#6	1	1
audit queue size	100	42	100	100
default network packet size	512	#191	512	512
disk i/o structures	256	21	256	256
enable rep agent threads	0	0	0	0
event buffers per engine	100	#59	100	100
executable codesize + overhead	0	14540	0	14540
max cis remote servers	25	0	25	25
max number network listeners	5	82	1	1
max online engines	1	895	6	6
max roles enabled per user	20	#10	20	20
memory per worker process	1024	51	1024	1024
number of alarms	40	7	40	40
number of aux scan descriptors	200	#99	200	200
number of devices	10	#35	80	80
number of languages in cache	3	4	3	3
number of large i/o buffers	6	241	15	15
number of locks	5000	5274	50000	50000
number of mailboxes	30	2	100	100
number of messages	64	36	1500	1500
number of open databases	12	434	12	12
number of open indexes	500	63	150	150
number of open objects	500	85	150	150
number of remote connections	20	33	20	20
number of remote logins	20	6	5	5
number of remote sites	10	245	3	3
number of user connections	25	4885	60	60
number of worker processes	0	4097	50	50
partition groups	1024	21	1024	1024
permission cache entries	15	#65	15	15
procedure cache percent	20	11600	18	18
remote server pre-read packets	3	#32	3	3
stack guard size	4096	#516	4096	4096
stack size	34816	#4387	34816	34816
total data cache size	0	51019	0	51019
total memory	12000	94000	47000	47000

A "#" in the "Memory Used" column indicates that this parameter is a component of another parameter and that its memory use is included in the memory use for the other component. For example, memory used for **stack size** and **stack guard size** contributes to the memory requirements for each user connection and worker process, so the value is included in the memory required for **number of user connections** or that for **number of worker processes**.

Some of the values in this list are computed values. They cannot be set directly with **sp_configure**, but are reported to show where memory is allocated. Among the computed values is **total data cache size**.

Using *sp_helpconfig* to Get Help on Configuration Parameters

sp_helpconfig estimates the amount of memory required for a given configuration parameter and value. It also provides a short description of the parameter, information about the minimum, maximum, and default values for the parameter, the run value, and the amount of memory used at the current run value. **sp_helpconfig** is particularly useful if you are planning substantial changes to a server, such as loading large, existing databases from other servers, and you want to estimate how much memory is needed.

To see how much memory is required to configure a parameter, enter enough of the parameter name so that it is a unique name and the value you want to configure:

```
sp_helpconfig "worker processes", "50"
```

```
number of worker processes is the maximum number of worker processes
that can be in use Server-wide at any one time.
Minimum Value Maximum Value Default Value Current Value Memory Used
------------- ------------- ------------- ------------- -----------
            0    2147483647             0             0           0

Configuration parameter, 'number of worker processes', will consume
4515K of memory if configured at 50.
```

You can also use **sp_helpconfig** to determine the value to use for **sp_configure**, if you know how much memory you want to allocate to a specific resource:

```
sp_helpconfig "user connections", "5M"
```

```
number of user connections sets the maximum number of user connections
that can be connected to SQL Server at one time.
Minimum Value Maximum Value Default Value Current Value Memory Used
------------- ------------- ------------- ------------- -----------
            5    2147483647            25            25       1982

Configuration parameter, 'number of user connections', can be configured
to 64 to fit in 5M of memory.
```

The important difference between the syntax of these two statements is the use of a unit of measure in the second example to indicate to the procedure that the value is a size, not a configuration value. The valid units of measure are:

- **P** – pages, (Adaptive Server 2K pages)
- **K** – kilobytes
- **M** – megabytes
- **G** – gigabytes

There are some cases where the syntax does not make sense for the type of parameter, or where Adaptive Server is not able to calculate the memory use. **sp_helpconfig** prints an error message in these cases. For example:

- Attempting to specify a size for a parameter that toggles, such as **allow resource limits**
- Attempting to specify a size value for a configuration parameter that is currently set to 0

For each of these conditions, and all configuration parameters that do not use memory, **sp_helpconfig** prints the message that describes the function of the parameter.

Using *sp_monitorconfig* to Find Metadata Cache Usage Statistics

sp_monitorconfig displays metadata cache usage statistics on certain shared server resources, including:

- The number of databases, objects, and indexes that can be open at any one time
- The number of auxiliary scan descriptors used by referential integrity queries
- The number of free and active descriptors
- The percentage of active descriptors

- The maximum number of descriptors used since the server was last started

For example, suppose you have configured the **number of open indexes** configuration parameter to 500. During a peak period, you can run **sp_monitorconfig** as follows to get an accurate reading of the actual metadata cache usage for index descriptors. For example:

```
sp_monitorconfig "number of open indexes"
Usage information at date and time: Aug 14 1997 8:54AM.

Name            # Free   # Active   % Active  # Max Ever Used   Re-used
--------------  --------  ------   --------   ---------------   -------
number of open  217       283      56.60      300               No
objects
```

In this report, the maximum number of open indexes used since the server was last started is 300, even though Adaptive Server is configured for 500. Therefore, you can reset the **number of open indexes** configuration parameter to 330, to accommodate the 300 maximum used index descriptors, plus space for 10 percent more.

Major Uses of Adaptive Server Memory

This section discusses configuration parameters that use large amounts of Adaptive Server memory and those that are commonly changed at a large number of Adaptive Server installations. These parameters should be checked by System Administrators who are configuring an Adaptive Server for the first time. System Administrators should review these parameters when the system configuration changes, after upgrading to a new release of Adaptive Server, or when making changes to other configuration variables that use memory.

Configuration parameters that use less memory, or that are less frequently used, are discussed in “Other Parameters That Use Memory” on page 14-13.

Adaptive Server Executable Code and Overhead

You must subtract the size of the Adaptive Server executable code and overhead from the total memory available to the Adaptive Server process. The size of the executable code plus overhead varies by platform and release, but generally ranges from 6MB to 8MB. To determine the size of the Adaptive Server executable and overhead for your platform, use **sp_configure** to display the value of the **executable**

codesize + overhead configuration parameter. See “executable codesize + overhead” on page 17-79 for more information.

When you enable Component Integration Services with the **enable cis** configuration parameter and then restart Adaptive Server, the size of the executable code and overhead increases. Other Component Integration Services configuration parameters use memory from the general pool of memory.

Data and Procedure Caches

As explained in “How Adaptive Server Uses Memory” on page 14-2, the data and procedure caches share all memory that is not dedicated to other resources within the server. Having sufficient data and procedure cache space is one of the most significant contributors to performance. This section explains the details of the split between the two caches and how to monitor cache sizes.

How Space Is Split Between Data and Procedure Cache

The proportion of remaining memory that goes to procedure cache depends on the run value of the **procedure cache percent** configuration parameter. A value of 20 indicates that 20 percent of the total cache space is used for procedure cache and the remaining 80 percent is used for data cache.

With a **procedure cache percent** value of 20 and 5.39MB of memory available after all other memory needs have been met, the results are

- Data cache: (5.39) * (0.8) = 4.31MB (or 2207 pages)
- Procedure cache: (5.39) * (0.2) = 1.08MB (or 552 pages).

Usually, the amount of procedure cache is slightly higher than the amount indicated in this calculation because a portion of the 6 percent of miscellaneous overhead that is not used is added to the procedure cache.

Monitoring Cache Space

You can check data cache and procedure cache space with **sp_configure**:

```
sp_configure "total data cache size"
sp_configure "procedure cache percent"
```

If you are using named caches, and the total data cache size has been decreased because of increases in other configuration parameters, use **sp_cacheconfig** to monitor the size of the default data cache. As the total data cache shrinks, only 2K pool of the default cache shrinks in size; your named caches are not affected, and large I/O pools in the default data cache are not affected. You may start to experience performance problems due to increased I/O if the 2K pool in the default cache becomes too small.

Monitoring Cache Sizes Using the Errorlog

Another way to determine how Adaptive Server uses memory is to examine the memory-related messages written to the error log when Adaptive Server starts. These messages state exactly how much data and procedure cache is allocated, how many **compiled objects** can reside in cache at any one time, and buffer pool sizes.

These messages provide the most accurate information regarding cache usage on Adaptive Server. As discussed earlier, the amount of memory allocated to data and procedure caches depends on the run value of the **procedure cache percent** configuration parameter.

Each of these error log messages is described below.

Procedure Cache Messages

Two error log messages provide information about the procedure cache.

```
server: Number of proc buffers allocated: 556
```

This message states the total number of procedure buffers (proc buffers) allocated in the procedure cache.

```
server: Number of blocks left for proc headers: 629
```

This message indicates the total number of procedure headers (proc headers) available for use in the procedure cache.

proc buffer

A **proc buffer** (procedure buffer) is a data structure used to manage compiled objects in the procedure cache. One proc buffer is used for every copy of a compiled object stored in the procedure cache. When Adaptive Server starts, it determines the number of proc buffers required and multiplies that value by the size of a single proc buffer (76 bytes) to obtain the total amount of memory required. It then allocates that amount of memory, treated as an array of proc buffers. Unlike some data structures, proc buffers can span pages.

proc header

A **proc header** (procedure header) is where a compiled object is stored while in the procedure cache. Depending on the size of the object to be stored, one or more proc headers may be required. The total number of compiled objects that can be stored in the procedure cache is limited by the number of available proc headers or proc buffers, whichever is less. Because stored procedures often use more than one page, the practical value of this number may be even lower.

The total size of procedure cache is the combined total of memory allocated to proc buffers (rounded up to the nearest page boundary), plus the memory allocated to proc headers.

Data Cache Messages

When Adaptive Server starts, it records the total size of each cache and the size of each pool in the cache in the error log. This example shows the default data cache with two pools and a user-defined cache with two pools:

```
Memory allocated for the default data cache cache: 8030 Kb
Size of the 2K memory pool: 7006 Kb
Size of the 16K memory pool: 1024 Kb
Memory allocated for the tuncache cache: 1024 Kb
Size of the 2K memory pool: 512 Kb
Size of the 16K memory pool: 512 Kb
```

As explained in “Monitoring Cache Space” on page 14-9, it is very important to monitor the size of the 2K memory pool in the default data cache if you are increasing the amount of memory used by other configuration parameters. The data cache error messages provide a means for a simple check when you restart Adaptive Server.

User Connections

The amount of memory required per user connection varies by platform, and it changes when you change other configuration variables, including:

- **default network packet size**
- **stack size** and **stack guard size**
- **user log cache size**
- **max roles enabled per user**

Changing any of these parameters changes the amount of space used by each user connection: You have to multiply the difference in size by the number of user connections. For example, if you have 300 user connections, and you are considering increasing the **stack size** from 34K to 40K, the new value requires 1800K more memory, reducing the size of the data and procedure caches.

Open Databases, Open Indexes, and Open Objects

The three configuration parameters that control the total number of databases, indexes, and objects that can be open at one time are managed by special caches called **metadata caches**. The metadata caches reside in the kernel and server structures portion of Adaptive Server memory. You configure space for each of these caches with these parameters:

- **number of open databases**
- **number of open indexes**
- **number of open objects**

When Adaptive Server opens a database or accesses an index or an object, it needs to read information about it in the corresponding system tables: *sysdatabases*, *sysindexes*, and *sysobjects*. The metadata caches for databases, indexes, or objects let Adaptive Server access the information that describes it in the *sysdatabases*, *sysindexes*, or *sysobjects* row directly in its in-memory structure. This improves performance because Adaptive Server bypasses expensive calls that require disk access. It also reduces synchronization and spinlock contention when Adaptive Server has to retrieve database, index, or object information at runtime.

Managing individual metadata caches for databases, indexes, or objects is beneficial for a database that contains a large number of indexes and objects and where there is high concurrency among users. For more information about configuring the number of metadata caches, see “number of open databases” on page 17-80, “number of open indexes” on page 17-82, and “number of open objects” on page 17-84.

Number of Locks

All processes in Adaptive Server share a pool of lock structures. As a first estimate for configuring the number of locks, multiply the number of concurrent user connections you expect, **plus** the **number of**

worker processes that you have configured, by 20. The number of locks required by queries can vary widely. See "number of locks" on page 17-67 for more information. For information on how worker processes use memory, see "Worker Processes" on page 14-13.

Database Devices and Disk I/O Structures

The **number of devices** configuration parameter controls the number of database devices that can be used by Adaptive Server for storing data. See "number of devices" on page 17-41 for more information.

When a user process needs to perform a physical I/O, the I/O is queued in a disk I/O structure. See "disk i/o structures" on page 17-40 for more information.

Other Parameters That Use Memory

This section discusses configuration parameters that use moderate amounts of memory or are infrequently used.

Parallel Processing

Parallel processing requires more memory than serial processing. The configuration parameters that affect parallel processing are:

- **number of worker processes**
- **memory per worker process**
- **partition groups**
- **number of mailboxes** and **number of messages**

Worker Processes

The configuration parameter **number of worker processes** sets the total number of worker processes available at one time in Adaptive Server. Each worker process requires about the same amount of memory as a user connection.

Changing any of these parameters changes the amount of memory required for each worker process:

- **default network packet size**
- **stack size** and **stack guard size**

- **user log cache size**
- **memory per worker process**
- **max roles enabled per user**

The **memory per worker process** configuration parameter controls the additional memory that is placed in a pool for all worker processes. This additional memory stores miscellaneous data structure overhead and inter-worker process communication buffers. See the *Performance and Tuning Guide* for information on setting **memory per worker process.**

Parallel Queries and the Procedure Cache

Each worker process makes its own copy of the query plan in space borrowed from the procedure cache. The coordinating process keeps two copies of the query plan in memory.

Partition Groups

You need to reconfigure the value only if you use a very large number of partitions in the tables on your server. See “partition groups” on page 17-142 for more information.

Remote Servers

Some configuration parameters that allow Adaptive Server to communicate with other Sybase servers such as Backup Server, Component Integration Services, or XP Server use memory.

The configuration parameters that affect remote servers and that use memory are:

- **number of remote sites**
- **number of remote connections**
- **number of remote logins**
- **remote server pre-read packets**

Number of Remote Sites

Set the **number of remote sites** configuration parameter to the number of simultaneous sites you need to communicate to or from on your server. If you use only Backup Server, and no other remote servers,

you can increase your data cache and procedure cache space by reducing this parameter to 1.

The connection from Adaptive Server to XP Server uses one remote site.

Other Configuration Parameters for RPCs

These configuration parameters for remote communication use only a small amount of memory for each connection:

- **number of remote connections**
- **number of remote logins**

Each simultaneous connection from Adaptive Server to XP Server for ESP execution uses one remote connection and one remote login.

Since the **remote server pre-read packets** parameter increases the space required for each connection configured by the **number of remote connections** parameter, increasing the number of pre-read packets can have a significant effect on memory use.

Delete this line; it's just a place holder.

Referential Integrity

If the tables in your databases use a large number of referential constraints, you may need to adjust the **number of aux scan descriptors** parameter, if user connections exceed the default setting. In most cases, the default setting is sufficient. If a user connection exceeds the current setting, Adaptive Server returns an error message suggesting that you increase the **number of aux scan descriptors** parameter setting.

Other Parameters That Affect Memory

Other parameters that affect memory are listed below. When you reset these configuration parameters, check the amount of memory they use and the effects of the change on your procedure and data cache.

- **additional network memory**
- **allow resource limits**
- **audit queue size**
- **max SQL text monitored**
- **number of alarms**
- **number of large i/o buffers**

- **event buffers per engine**
- **max number network listeners**
- **max online engines**
- **number of languages in cache**
- **permission cache entries**
-

15 Configuring Data Caches

The most common reason for administering data caches is to reconfigure them for performance. This chapter is primarily concerned with the **mechanics** of working with data caches. Chapter 32, "Memory Use and Performance," in the *Performance and Tuning Guide* discusses performance concepts associated with data caches.

This chapter describes how to create and administer named caches on Adaptive Server. Topics include:

The Data Cache on Adaptive Server

The data cache holds the data, index, and log pages currently in use as well as pages used recently by Adaptive Server. When you first install Adaptive Server, it has a single default data cache that is used for all data, index, and log activity. You can divide this cache by

creating named data caches. Also, you can create pools within the named caches and the default cache to perform large I/Os. You can then bind a database, table (including the *syslogs* table), index, or text or image page chain to a named data cache.

Large I/O sizes enable Adaptive Server to perform data prefetching when the query optimizer determines that prefetching would improve performance. For example, an I/O size of 16K means that Adaptive Server can read an entire extent, or eight 2K pages, all at once, rather than performing eight separate I/Os. See "Understanding the Query Optimizer," in the *Performance and Tuning Guide* for details about the optimizer.

Sorts can also take advantage of buffer pools configured for large I/O sizes.

The process of configuring named data caches divides the default cache into separate cache structures. The named data caches that you create can be used only by databases or database objects that are explicitly bound to them. All objects not explicitly bound to named data caches use the default data cache.

Adaptive Server provides user-configurable data caches to improve performance, especially for multiprocessor servers. See "The Data Cache" on page 32-7 of the *Performance and Tuning Guide*.

Figure 15-1 shows a data cache with the default cache and two named data caches. The default cache contains two pools, a 2K pool and a 16K pool. The *User_Table_Cache* cache has a 2K pool and a 16K pool. The *Log_Cache* has a 2K pool and a 4K pool.

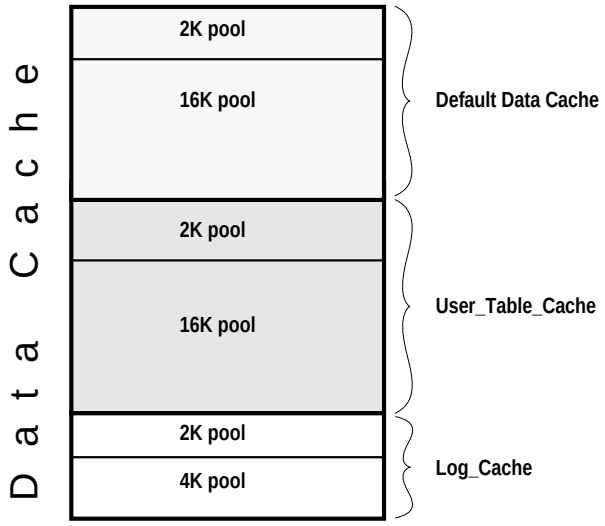

Figure 15-1: Data cache with default cache and two named data caches

Cache Configuration Commands

Table 15-1 lists commands for configuring named data caches, for binding and unbinding objects to caches, and for reporting on cache bindings. It also lists procedures that you might use to check the size of your database objects, and commands that control cache usage at the object, command, or session level.

Table 15-1: Procedures and commands for using named caches

Command	Function
sp_cacheconfig	Creates or drops named caches, and changes the size, cache type, cache policy or number of cache partitions.
sp_poolconfig	Creates and drops I/O pools, and changes their size, wash size, and asynchronous prefetch percent limit.
sp_bindcache	Binds databases or database objects to a cache.
sp_unbindcache	Unbinds specific objects or databases from a cache.
sp_unbindcache_all	Unbinds all objects bound to a specified cache.

Table 15-1: Procedures and commands for using named caches (continued)

Command	Function
sp_helpcache	Reports summary information about data caches and lists the databases and database objects that are bound to caches.
sp_cachestrategy	Reports on cache strategies set for a table or index, and disables or re-enables prefetching or MRU strategy.
sp_logiosize	Changes the default I/O size for the log.
sp_spaceused	Provides information about the size of tables and indexes or the amount of space used in a database.
sp_estspace	Estimates the size of tables and indexes, given the number of rows the table will contain.
sp_help	Reports the cache a table is bound to.
sp_helpindex	Reports the cache an index is bound to.
sp_helpdb	Reports the cache a database is bound to.
set showplan on	Reports on I/O size and cache utilization strategies for a query.
set statistics io on	Reports number of reads performed for a query.
set prefetch [on |off]	Enables or disables prefetching for an individual session.
select... (prefetch...lru | mru)	Forces the server to use the specified I/O size or MRU replacement strategy.

In addition to using the commands to configure named data caches interactively, you can also use the configuration file. See "Configuring Data Caches with the Configuration File" on page 15-32.

Information on Data Caches

Use **sp_cacheconfig** to create and configure named data caches. When you first install Adaptive Server, it has a single cache named "default data cache." To see information about caches, type:

```
sp_cacheconfig
```

```
Cache Name                Status    Type     Config Value Run Value
------------------------- --------- -------- ------------ ------------
default data cache        Active    Default       0.00 Mb     59.44 Mb
                                                ------------ ------------
                                    Total       0.00 Mb     59.44 Mb

===========================================================================
Cache: default data cache,   Status: Active,   Type: Default
     Config Size: 0.00 Mb,   Run Size: 59.44 Mb
     Config Replacement: strict LRU,   Run Replacement: strict LRU
     Config Partition:            1,   Run Partition:            1

IO Size  Wash Size Config Size  Run Size     APF Percent
-------- --------- ------------ ------------ -----------
    2 Kb  12174 Kb      0.00 Mb     59.44 Mb     10
```

Summary information for each cache is printed in a block at the top of the report, ending with a total size for all configured caches. For each cache, there is a block of information reporting the configuration for the memory pools in the cache.

The meanings of the columns in the block of output describing caches are:

- "Cache Name" gives the name of the cache.
- "Status" indicates whether the cache is active. Possible values are:
  - "Pend / Act" – the cache was just created and will be active after a restart.
  - "Active" – the cache is currently active.
  - "Pend / Del" – the cache is active, but will be deleted at the next restart of the server. The cache size was reset to 0 interactively.
- "Type" indicates whether the cache can store data and log pages ("Mixed") or log pages only ("Log Only"). Only the default cache has the type "Default." You cannot change the type of the default data cache or change the type of any other cache to "Default."
- "Config Value" displays the size of the cache after the next restart of Adaptive Server. In the preceding example output, the default data cache has not been explicitly configured, so its size is 0.
- "Run Value" displays the size that Adaptive Server is currently using. For the default data cache, this size is always the amount of all data cache space that is not explicitly configured to another cache.

The second block of output begins with three lines of information that describe the cache. The first two lines repeat information from

the summary block at the top. On the third line, "Config Replacement" and "Run Replacement" show the cache policy, which is either "strict LRU" or "relaxed LRU." The run setting is the setting in effect; if the policy has been changed since the server was restarted, the config setting will be different from the run setting.

sp_cacheconfig then provides a row of information for each pool in the cache:

- "IO Size" shows the size of the buffers in the pool. When you first configure a cache, all the space is assigned to the 2K pool. Valid sizes are 2K, 4K, 8K, and 16K.
- "Wash Size" indicates the wash size for the pool. See "Changing the Wash Area for a Memory Pool" on page 15-20.
- "Config Size" and "Run Size" display the configured size and the size currently in use. These differ for the 2K pool because you cannot explicitly configure its size. These may differ for other pools if you have tried to move space between them, and some of the space could not be freed.
- "Config Partition" and "Run Partition" display the configured number of cache partitions and the number of partitions currently in use. These may differ if you have changed the number of partitions since last reboot.
- "APF Percent" displays the percentage of the pool that can hold unused buffers brought in by asynchronous prefetch.

A summary line prints the total size of the cache or caches displayed.

Configuring Data Caches

After all other memory needs on Adaptive Server have been satisfied, all remaining space is available for the data cache. The first step in planning cache configuration and implementing caches is to set the **total memory** configuration parameter. After you set the configuration parameter and restart Adaptive Server, you can see exactly how much space is available for data caches on your server. For an overview of Adaptive Server memory usage, see Chapter 14, "Configuring Memory."

You can configure data caches in two ways:

- Interactively, using **sp_cacheconfig** and **sp_poolconfig**
- By editing your configuration file

The following sections describe the process of cache configuration using **sp_cacheconfig** and **sp_poolconfig.** See "Configuring Data Caches with the Configuration File" on page 15-32 for information about using the configuration file.

Each time you execute **sp_cacheconfig** or **sp_poolconfig**, Adaptive Server writes the new cache or pool information into the configuration file and copies the old version of the file to a backup file. A message giving the backup file name is sent to the error log.

The syntax to create a new cache is:

sp_cacheconfig *cache_name*, "*size*[P|K|M|G]"

Size units can be specified with:

- **P** – Pages, (Adaptive Server 2K pages)
- **K** – Kilobytes (default)
- **M** – Megabytes
- **G** – Gigabytes

Maximum data cache size is limited only by the amount of memory available on your system.

This command configures a 10MB cache named *pubs_cache*:

```
sp_cacheconfig pubs_cache, "10M"
```

This command makes changes in the system tables and writes the new values to the configuration file, but does not activate the cache. You must restart Adaptive Server for the changes to take effect.

Using **sp_cacheconfig** to see the configuration before a restart shows different "Config" and "Run" values:

```
sp_cacheconfig pubs_cache
```

```
Cache Name                Status    Type     Config Value Run Value
------------------------- --------- -------- ------------ ------------
pubs_cache                Pend/Act  Mixed        10.00 Mb      0.00 Mb
                                                ------------ ------------
                                     Total      10.00 Mb      0.00 Mb
```

The status "Pend / Act" for *pubs_cache* shows that the configuration of this cache is pending, waiting for a restart. "Config Value" displays 10MB, and "Run Value" displays the value 0. Run values and configuration values are also different when you delete caches and when you change their size.

The section of output that provides detail about pools is not printed for caches that are not active.

After a restart of Adaptive Server, **sp_cacheconfig** reports:

```
                sp_cacheconfig
Cache Name                Status    Type     Config Value Run Value
------------------------- --------- -------- ------------ ------------
default data cache        Active    Default       0.00 Mb     49.37 Mb
pubs_cache                Active    Mixed        10.00 Mb     10.00 Mb
                                                ------------ ------------
                                      Total      10.00 Mb     59.37 Mb
===========================================================================
Cache: default data cache,   Status: Active,   Type: Default
     Config Size: 0.00 Mb,   Run Size: 49.37 Mb
     Config Replacement: strict LRU,   Run Replacement: strict LRU
     Config Partition:            1,   Run Partition:            1

IO Size  Wash Size Config Size  Run Size     APF Percent
-------- --------- ------------ ------------ -----------
    2 Kb  10110 Kb      0.00 Mb     49.37 Mb     10
===========================================================================
Cache: pubs_cache,   Status: Active,   Type: Mixed
     Config Size: 10.00 Mb,   Run Size: 10.00 Mb
     Config Replacement: strict LRU,   Run Replacement: strict LRU
     Config Partition:            1,   Run Partition:            1

IO Size  Wash Size Config Size  Run Size     APF Percent
-------- --------- ------------ ------------ -----------
    2 Kb   2048 Kb      0.00 Mb     10.00 Mb     10
```

The *pubs_cache* is now active, and all the space is assigned to the 2K pool. The size of the default cache has been reduced by 10MB. The remainder of the difference in the size of the default cache and the total amount of cache available is due to changing overhead values. See "How Overhead Affects Total Cache Space" on page 15-18 for examples.

You can create as many caches as you want before restarting Adaptive Server. You must restart Adaptive Server before you can configure pools or bind objects to newly created caches.

Explicitly Configuring the Default Cache

If you want to "lock in" some portion of the cache space for the default data cache, you can execute **sp_cacheconfig** with **default data cache** and a size value. This command ensures that no other cache configuration commands reduce the size of the default cache to less than 25MB:

```
sp_cacheconfig "default data cache", "25M"
```

After a restart of the server, "Config Value" shows the value.

```
sp_cacheconfig
```

```
Cache Name                Status    Type     Config Value Run Value
------------------------- --------- -------- ------------ ------------
default data cache        Active    Default      25.00 Mb     49.37 Mb
pubs_cache                Active    Mixed        10.00 Mb     10.00 Mb
                                                ------------ ------------
                                      Total      10.00 Mb     59.37 Mb
===========================================================================
Cache: default data cache,   Status: Active,   Type: Default
     Config Size: 25.00 Mb,   Run Size: 49.37 Mb
     Config Replacement: strict LRU,   Run Replacement: strict LRU
     Config Partition:            1,   Run Partition:            1

IO Size  Wash Size Config Size  Run Size     APF Percent
-------- --------- ------------ ------------ -----------
    2 Kb  10110 Kb     00.00 Mb     49.37 Mb     10
===========================================================================
Cache: pubs_cache,   Status: Active,   Type: Mixed
     Config Size: 10.00 Mb,   Run Size: 10.00 Mb
     Config Replacement: strict LRU,   Run Replacement: strict LRU
     Config Partition:            1,   Run Partition:            1

IO Size  Wash Size Config Size  Run Size     APF Percent
-------- --------- ------------ ------------ -----------
    2 Kb   2048 Kb      0.00 Mb     10.00 Mb     10
```

This command sets a minimum size for the default data cache. You can change the minimum, but you cannot inadvertently allocate this space to other caches. With a minimum default data cache size set, the "Run Value" still shows that the default data cache is allocated all of the memory not explicitly allocated to other caches.

➤ ***Note***

If you lock in space in the default data cache and then reduce the amount of memory available below that level, Adaptive Server will not start. Both editing your configuration file to increase the size of other caches and increasing the values of configuration parameters that require memory can reduce the size of the default data cache. See Chapter 14, "Configuring Memory," for information on configuration parameters that require memory.

You might want to lock in memory for the default cache as a protection for performance, which depends on enough space being available in the cache for data and index pages. Many configuration parameters use memory, and when the configuration values for these parameters is increased, the result is a reduction in space for the 2K pool in the default data cache. All other cache space is explicitly configured with **sp_cacheconfig**, and other pools in the default data cache are explicitly configured with **sp_poolconfig**.

Changing a Cache's Type

To reserve a cache for use only by the transaction log, change the cache's type to "logonly." This example creates the cache *pubs_log* with the type "logonly:"

```
sp_cacheconfig pubs_log, "7M", "logonly"
```

The following shows the state of the cache before a restart:

```
Cache Name          Status    Type     Config Value Run Value
------------------- --------- -------- ------------ ------------
pubs_log            Pend/Act  Log Only      7.00 Mb      0.00 Mb
                                       ------------ ------------
                                Total       7.00 Mb      0.00 Mb
```

You can change the type of an existing "mixed" cache, as long as no non-log objects are bound to it:

```
sp_cacheconfig pubtune_cache, logonly
```

➤ ***Note***

In high transaction environments, Adaptive Server usually performs best with a 4K pool configured for the transaction log. For information on configuring caches for improved log performance, see "Matching Log I/O Size for Log Caches" on page 15-14.

Configuring Cache Replacement Policy

If a cache is dedicated to a table or an index, and the cache has little or no buffer replacement when the system reaches a stable state, you can set relaxed LRU (least recently used) replacement policy. Relaxed LRU replacement policy can improve performance for caches where there is little or no buffer replacement occurring, and for most log caches. See Chapter 32, "Memory Use and Performance," in the *Performance and Tuning Guide* for more information. To set relaxed replacement policy, use:

```
sp_cacheconfig pubs_log, relaxed
```

The default value is "strict."

You can create a cache and specify its cache type and the replacement policy in one command:

```
sp_cacheconfig pubs_log, "3M", logonly, relaxed
sp_cacheconfig pubs_cache, "10M", mixed, strict
```

You must restart Adaptive Server for cache replacement policy changes to take effect. Here are the results after a restart:

```
sp_cacheconfig
Cache Name                Status    Type     Config Value Run Value
------------------------- --------- -------- ------------ ------------
default data cache        Active    Default      25.00 Mb     42.29 Mb
pubs_cache                Active    Mixed        10.00 Mb     10.00 Mb
pubs_log                  Active    Log Only      7.00 Mb      7.00 Mb
                                                ------------ ------------
                                      Total      42.00 Mb     59.29 Mb
===========================================================================
Cache: default data cache,   Status: Active,   Type: Default
     Config Size: 25.00 Mb,   Run Size: 42.29 Mb
     Config Replacement: strict LRU,   Run Replacement: strict LRU
     Config Partition:            1,   Run Partition:            1

IO Size  Wash Size Config Size  Run Size     APF Percent
-------- --------- ------------ ------------ -----------
    2 Kb   8662 Kb      0.00 Mb     42.29 Mb     10
===========================================================================
Cache: pubs_cache,   Status: Active,   Type: Mixed
     Config Size: 10.00 Mb,   Run Size: 10.00 Mb
     Config Replacement: strict LRU,   Run Replacement: strict LRU
     Config Partition:            1,   Run Partition:            1

IO Size  Wash Size Config Size  Run Size     APF Percent
-------- --------- ------------ ------------ -----------
    2 Kb   2048 Kb      0.00 Mb     10.00 Mb     10
===========================================================================
Cache: pubs_log,   Status: Active,   Type: Log Only
     Config Size: 7.00 Mb,   Run Size: 7.00 Mb
     Config Replacement: relaxed LRU,   Run Replacement: relaxed LRU
     Config Partition:            1,   Run Partition:            1

IO Size  Wash Size Config Size  Run Size     APF Percent
-------- --------- ------------ ------------ -----------
    2 Kb   1432 Kb      0.00 Mb      7.00 Mb     10
```

Dividing a Data Cache into Memory Pools

After you create a data cache, you can divide it into memory pools, each with a different I/O size. In any cache, you can have only one pool of each I/O size.

When Adaptive Server performs large I/Os, multiple pages are read into the cache at the same time. These pages are always treated as a unit: they age in the cache and are written to disk as a unit.

By default, when you create a named data cache, all of its space is assigned to the default 2K memory pool. Creating additional pools reassigns some of that space to other pools, reducing the size of the 2K pool. For example, if you create a data cache with 50MB of space, all the space is assigned to the 2K pool. If you configure a 4K pool with 30MB of space in this cache, the 2K pool is reduced to 20MB.

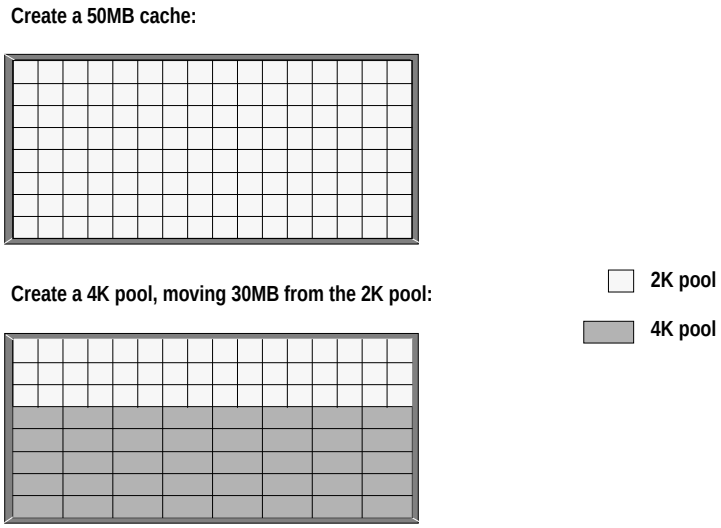

Figure 15-2: Configuring a cache and a 4K memory pool

After you create the pools, you can move space between them. For example, in a cache with a 20MB 2K pool and a 30MB 4K pool, you can configure a 16K pool, taking 10MB of space from the 4K pool.

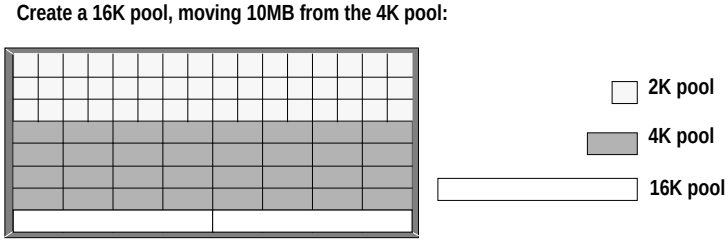

Figure 15-3: Moving space from an existing pool to a new pool

The commands that move space between pools within a cache do not require a restart of Adaptive Server to take effect, so you can reconfigure pools to meet changing application loads with little impact on server activity.

In addition to creating pools in the caches you configure, you can add memory pools for I/Os up to 16K to the default data cache.

The syntax for configuring memory pools is:

```
sp_poolconfig cache_name, "memsize[P|K|M|G]",
   "config_poolK" [, "affected_poolK"]
```

Pool configuration always configures the *config_pool* to the size specified in the command. It always affects a second pool (the *affected_pool*) by moving space to or from that pool. If you do not specify the *affected_pool*, the space is taken from or allocated to the 2K pool. The minimum size for a pool is 512K.

This example creates a 7MB pool of 16K pages in the *pubs_cache* data cache:

```
sp_poolconfig pubs_cache, "7M", "16K"
```

This command reduces the size of the 2K memory pool. To see the current configuration, run **sp_cacheconfig**, giving only the cache name:

```
sp_cacheconfig pubs_cache
```

```
Cache Name                Status    Type     Config Value Run Value
------------------------- --------- -------- ------------ ------------
pubs_cache                Active    Mixed        10.00 Mb     10.00 Mb
                                                ------------ ------------
                                      Total      10.00 Mb     10.00 Mb
===========================================================================
Cache: pubs_cache,   Status: Active,   Type: Mixed
     Config Size: 10.00 Mb,   Run Size: 10.00 Mb
     Config Replacement: strict LRU,   Run Replacement: strict LRU
     Config Partition:            1,   Run Partition:            1

IO Size  Wash Size Config Size  Run Size     APF Percent
-------- --------- ------------ ------------ -----------
    2 Kb   2048 Kb      0.00 Mb      3.00 Mb     10
   16 Kb   1424 Kb      7.00 Mb      7.00 Mb     10
```

You can also create memory pools in the default data cache.

In the following example, you start with this cache configuration:

```
Cache Name                Status    Type     Config Value Run Value
------------------------- --------- -------- ------------ ------------
default data cache        Active    Default      25.00 Mb     42.29 Mb
                                                ------------ ------------
                                      Total      25.00 Mb     42.29 Mb
===========================================================================
Cache: default data cache,   Status: Active,   Type: Default
     Config Size: 25.00 Mb,   Run Size: 42.29 Mb
     Config Replacement: strict LRU,   Run Replacement: strict LRU
     Config Partition:            1,   Run Partition:            1

IO Size  Wash Size Config Size  Run Size     APF Percent
-------- --------- ------------ ------------ -----------
    2 Kb   8662 Kb      0.00 Mb     42.29 Mb     10
```

This command creates a 16K pool in the default data cache:

```
sp_poolconfig "default data cache", "8M", "16K"
```

It results in this configuration, reducing the "Run Size" of the 2K pool:

```
Cache Name                Status    Type     Config Value Run Value
------------------------- --------- -------- ------------ ------------
default data cache        Active    Default      25.00 Mb     42.29 Mb
                                                ------------ ------------
                                      Total      25.00 Mb     42.29 Mb
===========================================================================
Cache: default data cache,   Status: Active,   Type: Default
     Config Size: 25.00 Mb,   Run Size: 42.29 Mb
     Config Replacement: strict LRU,   Run Replacement: strict LRU
     Config Partition:            1,   Run Partition:            1

IO Size  Wash Size Config Size  Run Size     APF Percent
-------- --------- ------------ ------------ -----------
    2 Kb   8662 Kb      0.00 Mb     34.29 Mb     10
   16 Kb   1632 Kb      8.00 Mb      8.00 Mb     10
```

You do not need to configure the size of the 2K memory pool in caches that you create. Its "Run Size" represents all the memory not explicitly configured to other pools in the cache.

Matching Log I/O Size for Log Caches

If you create a cache for the transaction log of a database, configure most of the space in that cache to match the log I/O size. The default value is 4K, but Adaptive Server uses 2K I/O for the log if a 4K pool is not available. The log I/O size can be changed with **sp_logiosize**. The log I/O size of each database is reported in the error log when Adaptive Server starts, or you can check the size of a database by using the database and issuing **sp_logiosize** with no parameters.

This example creates a 4K pool in the *pubs_log* cache:

```
sp_poolconfig pubs_log, "3M", "4K"
```

You can also create a 4K memory pool in the default data cache for use by transaction logs of any databases that are not bound to another cache:

```
sp_poolconfig "default data cache", "2.5M", "4K"
```

See Chapter 32, "Choosing the I/O Size for the Transaction Log," in the *Performance and Tuning Guide* for information on tuning the log I/O size.

Binding Objects to Caches

sp_bindcache assigns a database, table, index or text/image object to a cache. Before you can bind an entity to a cache, the following conditions must be met:

- The named cache must exist, and its status must be "Active."
- The database or database object must exist.
- To bind tables, indexes, or objects, you must be using the database where they are stored.
- To bind system tables, including the transaction log table *syslogs*, the database must be in single-user mode.
- To bind a database, you must be using *master*, and the database must be in single-user mode.
- To bind a database, user table, index, text object, or image object to a cache, the type of cache must be "Mixed." Only the *syslogs* table can be bound to a cache of "Log Only" type.
- You must own the object or be the Database Owner or the System Administrator.

You must restart Adaptive Server after creating caches in order to bind objects to them. Bindings take effect immediately and do not require a restart.

The syntax for binding objects to caches is:

```
sp_bindcache cache_name, dbname [,[owner.]tablename
   [, indexname |  "text only" ] ]
```

The owner name is optional if the table is owned by "dbo."

This command binds the *titles* table to the *pubs_cache*:

```
sp_bindcache  pubs_cache, pubs2, titles
```

To bind an index on *titles*, add the index name as the third parameter:

```
sp_bindcache pubs_cache, pubs2,  titles, titleind
```

The owner name is not needed in the examples above because the objects in the *pubs2* database are owned by "dbo." To specify a table owned by any other user, add the owner name. You must enclose the parameter in quotation marks, since the period in the parameter is a special character:

```
sp_bindcache pubs_cache, pubs2, "fred.sales_east"
```

This command binds the transaction log, *syslogs*, to the *pubs_log* cache:

```
sp_bindcache pubs_log, pubs2, syslogs
```

The database must be in single-user mode before you can bind any system tables, including the transaction log, *syslogs*, to a cache. Use **sp_dboption** from *master*, and a **use *database*** command, and run **checkpoint**:

```
sp_dboption pubs2, single, true

use pubs2

checkpoint
```

text and *image* columns for a table are stored in a separate data structure in the database. To bind this object to a cache, add the "text-only" parameter:

```
sp_bindcache pubs_cache, pubs2, au_pix,
"text only"
```

This command, executed from *master*, binds the *tempdb* database to a cache:

```
sp_bindcache tempdb_cache, tempdb
```

You can rebind objects without dropping existing bindings.

Cache Binding Restrictions

You cannot bind or unbind a database object:

- When dirty reads are active on the object
- When a cursor is open on the object

In addition, Adaptive Server needs to lock the object while the binding or unbinding takes place, so the procedure may have a slow response time, because it waits for locks to be released. See "Locking to Perform Bindings" on page 15-32 for more information.

Getting Information About Cache Bindings

sp_helpcache provides information about a cache and the entities bound to it when you provide the cache name:

```
sp_helpcache pubs_cache
```

```
Cache Name           Config Size     Run Size       Overhead
---------------------- ------------   ----------     ----------
pubs_cache            10.50 Mb       10.50 Mb        0.56 Mb

------------------ Cache Binding Information: ------------------

Cache Name      Entity Name           Type   Index Name  Status
----------      -----------           ----   ----------  ------
pubs_cache      pubs2.dbo.titles      index  titleind    V
pubs_cache      pubs2.dbo.au_pix      index  tau_pix     V
pubs_cache      pubs2.dbo.titles      table              V
pubs_cache      pubs2.fred.sales_east table              V
```

If you use **sp_helpcache** without a cache name, it prints information about all the configured caches on Adaptive Server and all the objects that are bound to them.

sp_helpcache performs string matching on the cache name, using %*cachename*%. For example, "pubs" matches both "pubs_cache" and "pubs_log."

The "Status" column reports whether a cache binding is valid ("V") or invalid ("I"). If a database or object is bound to a cache, and the cache is deleted, binding information is retained in the system tables, but the cache binding is marked as invalid. All objects with invalid bindings use the default data cache. If you subsequently create another cache with the same name, the binding becomes valid when the cache is activated by a restart of Adaptive Server.

Checking Cache Overhead

sp_helpcache can report the amount of overhead required to manage a named data cache of a given size. When you create a named data cache, all the space you request with **sp_cacheconfig** is made available for cache space. The memory needed for cache management is taken from the default data cache.

To see the overhead required for a cache, give the proposed size. You can use **P** for pages, **K** for kilobytes, **M** for megabytes, or **G** for gigabytes. The following examples check the overhead for 20,000 pages:

```
sp_helpcache "20000P"
```

```
2.08Mb of overhead memory will be needed to manage
a cache of size 20000P
```

Note that you are not wasting any cache space by configuring user caches. About 5% of memory is required for the structures that store and track pages in memory, whether you use a single large data cache or several smaller caches.

How Overhead Affects Total Cache Space

The example detailed in "Information on Data Caches" on page 15-4 and "Configuring Data Caches" on page 15-6 shows a default data cache with 59.44 MB of cache space available before any user-defined caches are created. When the 10MB *pubs_cache* is created and Adaptive Server is restarted, the results of **sp_cacheconfig** show a total cache size of 59.44 MB.

The process of configuring a data cache can appear to increase or decrease the total available cache. The explanation for this lies in the amount of overhead required to manage a cache of a particular size, and the fact that the overhead is not included in the values displayed by **sp_cacheconfig**.

Using **sp_helpcache** to check the overhead of the original 59.44MB default cache and the new 10MB cache shows that the change in space is due to changes in the size of overhead. The following command shows the overhead for the default data cache before any changes were made:

```
sp_helpcache "59.44M"

3.04Mb of overhead memory will be needed to manage
a cache of size 59.44M
```

This command shows the overhead for *pubs_cache*:

```
sp_helpcache "10M"

0.53Mb of overhead memory will be needed to manage
a cache of size 10M
```

The following calculations add the overhead required to manage the original cache space and then subtract the overhead for *pubs_cache*.

Original total cache size (overhead not included)	59.44
Overhead for 59.44 MB default cache	+3.04
Total cache space, including overhead	62.48
Subtract 10MB *pubs_cache* and .53MB overhead	- 10.53
Remaining space	51.95
Overhead for 51.95MB cache	- 2.69
Usable size of the default cache	49.26

Cache sizes are rounded to two places when printed by **sp_cacheconfig**, and overhead is rounded to two places by **sp_helpcache**, so you will see a small amount of rounding error in the output.

Dropping Cache Bindings

Two commands drop cache bindings:

- **sp_unbindcache** unbinds a single entity from a cache.
- **sp_unbindcache_all** unbinds all objects bound to a cache.

The syntax for **sp_unbindcache** is:

```
sp_unbindcache dbname [,[owner.]tablename
   [, indexname | "text only"] ]
```

This command unbinds the *pubs2* database:

```
sp_unbindcache pubs2
```

This command unbinds the *titles* table:

```
sp_unbindcache pubs2, titles
```

This commands unbinds the *titleidind* index:

```
sp_unbindcache pubs2, titles, titleidind
```

To unbind all the objects bound to a cache, use **sp_unbindcache_all**, giving the cache's name:

```
sp_unbindcache_all pubs_cache
```

You cannot use **sp_unbindcache_all** if more than eight databases and / or objects in eight databases are bound to the cache. You must use **sp_unbindcache** on individual databases or objects to reduce the number of databases involved to eight or less.

When you drop a cache binding for an object, all the pages currently in memory are cleared from the cache.

Changing the Wash Area for a Memory Pool

When Adaptive Server needs to read a buffer into cache, it places:

- The buffer at the LRU (least recently used) end of each memory pool, in a cache with strict LRU policy
- The buffer at the victim pointer, in a cache with relaxed LRU policy. If the recently used bit of buffer at the victim marker is set, the victim pointer is moved to the next buffer in the pool.

A portion of each pool is configured as the **wash area**. After dirty pages (pages that have been changed in cache) pass the wash marker and enter the wash area, Adaptive Server starts an asynchronous I/O on the page. When the write completes, the page is marked clean and remains available in the cache.

The space in the wash area must be large enough so that the I/O on the buffer can complete before the page needs to be replaced. Figure 15-4 illustrates how the wash area of a buffer pool works with a strict and relaxed LRU cache:

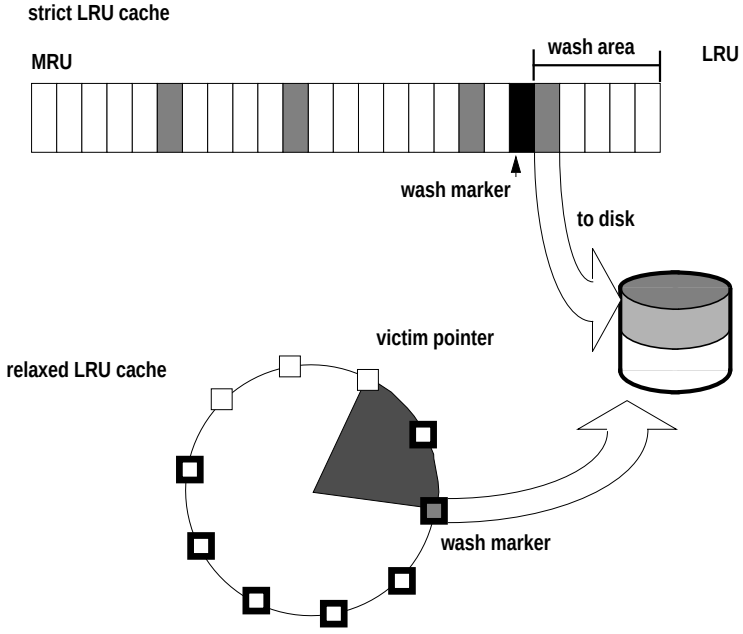

Figure 15-4: Wash area of a buffer pool

By default, the size of the wash area for a memory pool is configured as follows:

- If the pool size is less than 300MB, the default wash size is set to 20% of the buffers in the pool.
- If the pool size is greater than 300MB, the default wash size is 20% of the number of buffers in 300MB.

The minimum wash size is 10 buffers. The maximum size of the wash area is 80% of the pool size.

A buffer is a block of pages that matches the I/O size for the pool. Each buffer is treated as a unit: all pages in the buffer are read into cache, written to disk, and aged in the cache as a unit. For a 2K pool, 256 buffers equals 512K; for a 16K pool, 256 buffers equals 4096K.

For example, if you configure a 16K pool with 1MB of space, the pool has 64 buffers; 20% of 64 is 12.8. This is rounded down, so 12 buffers, or 192K, are allocated to the wash area.

When the Wash Area Is Too Small

If the wash area is too small for the usage in a buffer pool, operations that need a clean buffer may have to wait for I/O to complete on the dirty buffer at the LRU end of the pool or at the victim marker. This is called a **dirty buffer grab**, and it can seriously slow performance. Figure 15-5 shows a dirty buffer grab on a strict replacement policy cache.

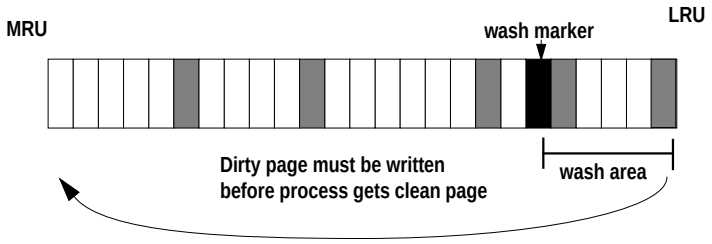

Figure 15-5: Small wash area results in a dirty buffer grab

You can use **sp_sysmon** to determine whether dirty buffer grabs are taking place in your memory pools. Run **sp_sysmon** while the cache is experiencing a heavy period of I/O and heavy update activity, since it is the combination of many dirty pages and high cache replacement rates that usually causes dirty buffer grabs.

If the "Buffers Grabbed Dirty" output in the cache summary section shows a nonzero value in the "Count" column, check the "Grabbed Dirty" row for each pool to determine where the problem lies. Increase the size of the wash area for the affected pool. This command sets the wash area of the 2K memory pool to 720K:

```
sp_poolconfig pubs_cache, "2K", "wash=720K"
```

If the pool is very small, you may also want to increase its pool size, especially if **sp_sysmon** output shows that the pool is experiencing high turnover rates.

For more information, See the *Performance and Tuning Guide* for more information.

When the Wash Area Is Too Large

If the wash area is too large in a pool, the buffers move too quickly past the "wash marker" in cache, and an asynchronous write is started on any dirty buffers, as shown in Figure 15-6. The buffer is

marked “clean” and remains in the wash area of the MRU/LRU chain until it reaches the LRU. If another query changes a page in the buffer, Adaptive Server must perform additional I/O to write it to disk again.

If **sp_sysmon** output shows a high percentage of buffers “Found in Wash” for a strict replacement policy cache, and there are no problems with dirty buffer grabs, you may want to try reducing the size of the wash area. See the *Performance and Tuning Guide* for more information.

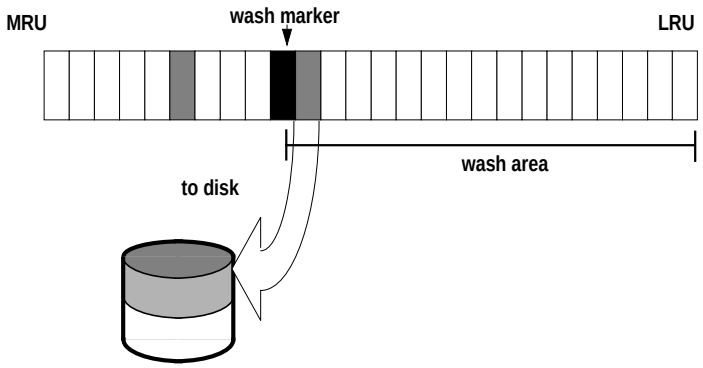

Figure 15-6: Effects of making the wash area too large

Changing the Asynchronous Prefetch Limit for a Pool

The asynchronous prefetch limit specifies the percentage of the pool that can be used to hold pages that have been brought into the cache by asynchronous prefetch, but have not yet been used by any queries. The default value for the server is set with the configuration parameter **global async prefetch limit**. Pool limits, set with **sp_poolconfig**, override the default limit for a single pool.

This command sets the percentage for the 2K pool in the *pubs_cache* to 20:

```
sp_poolconfig pubs_cache, "2K",
   "local async prefetch limit=20"
```

Changes to the prefetch limit for a pool take effect immediately and do not require a restart of Adaptive Server. Valid values are 0–100. Setting the prefetch limit to 0 disables asynchronous prefetching in a pool. For information about the impact of asynchronous prefetch on

performance, see Chapter 34, "Tuning Asynchronous Prefetch," in the *Performance and Tuning Guide*.

Resizing Named Data Caches

To change the size of an existing cache, issue **sp_cacheconfig**, specifying a new total size for the cache. When you increase the size of a cache by specifying a larger size with **sp_cacheconfig**, all the additional space is added to the 2K pool. When you decrease the size of a cache, all the space is taken from the 2K pool. You cannot decrease the size of the 2K pool to less than 512K.

Increasing the Size of a Cache

sp_cacheconfig reports that *pubs_cache* is currently configured with 10MB of space:

```
sp_cacheconfig pubs_cache
```

```
Cache Name               Status    Type     Config Value Run Value
------------------------ --------- -------- ------------ ------------
pubs_cache               Active    Mixed        10.00 Mb     10.00 Mb
                                                ------------ ------------
                                     Total      10.00 Mb     10.00 Mb
===========================================================================
Cache: pubs_cache,   Status: Active,   Type: Mixed
     Config Size: 10.00 Mb,   Run Size: 10.00 Mb
     Config Replacement: strict LRU,   Run Replacement: strict LRU
     Config Partition:            1,   Run Partition:            1

IO Size  Wash Size Config Size  Run Size     APF Percent
-------- --------- ------------ ------------ -----------
    2 Kb    720 Kb      0.00 Mb      3.00 Mb     20
   16 Kb   1424 Kb      7.00 Mb      7.00 Mb     10
```

To increase the size of the cache and its 2K pool, specify the new total size of the cache:

```
sp_cacheconfig pubs_cache, "20M"
```

This output reports the configuration before a restart:

```
Cache Name                Status    Type     Config Value Run Value
------------------------- --------- -------- ------------ ------------
pubs_cache                Active    Mixed        20.00 Mb     10.00 Mb
                                                ------------ ------------
                                      Total      20.00 Mb     10.00 Mb
===========================================================================
Cache: pubs_cache,   Status: Active,   Type: Mixed
     Config Size: 10.00 Mb,   Run Size: 10.00 Mb
     Config Replacement: strict LRU,   Run Replacement: strict LRU
     Config Partition:            1,   Run Partition:            1

IO Size  Wash Size Config Size  Run Size     APF Percent
-------- --------- ------------ ------------ -----------
    2 Kb    720 Kb      0.00 Mb      3.00 Mb     20
   16 Kb   1424 Kb      7.00 Mb      7.00 Mb     10
```

The additional 10MB has been configured and becomes available in the 2K pool at the next restart.

Decreasing the Size of a Cache

You can also reduce the size of a cache. For example, following is a report on the *pubs_log* cache:

```
sp_cacheconfig pubs_log
```

```
Cache Name                Status    Type     Config Value Run Value
------------------------- --------- -------- ------------ ------------
pubs_log                  Active    Log Only      7.00 Mb      7.00 Mb
                                                ------------ ------------
                                      Total       7.00 Mb      7.00 Mb
===========================================================================
Cache: pubs_log,   Status: Active,   Type: Log Only
     Config Size: 7.00 Mb,   Run Size: 7.00 Mb
     Config Replacement: relaxed LRU,   Run Replacement: relaxed LRU
     Config Partition:            1,   Run Partition:            1

IO Size  Wash Size Config Size  Run Size     APF Percent
-------- --------- ------------ ------------ -----------
    2 Kb    920 Kb      0.00 Mb      4.50 Mb     10
    4 Kb    512 Kb      2.50 Mb      2.50 Mb     10
```

The following command reduces the size of the *pubs_log* cache, reducing the size of the 2K pool:

```
sp_cacheconfig pubs_log, "6M"
```

After a restart of Adaptive Server, **sp_cacheconfig** shows:

```
ache Name                Status    Type     Config Value Run Value
------------------------ --------- -------- ------------ ------------
pubs_log                  Active    Log Only      6.00 Mb      6.00 Mb
                                                ------------ ------------
                                      Total       6.00 Mb      6.00 Mb
===========================================================================
Cache: pubs_log,   Status: Active,   Type: Log Only
     Config Size: 6.00 Mb,   Run Size: 6.00 Mb
     Config Replacement: relaxed LRU,   Run Replacement: relaxed LRU
     Config Partition:            1,   Run Partition:            1

IO Size  Wash Size Config Size  Run Size     APF Percent
-------- --------- ------------ ------------ -----------
    2 Kb    716 Kb      0.00 Mb      3.50 Mb     10
    4 Kb    512 Kb      2.50 Mb      2.50 Mb     10
```

When you reduce the size of a data cache, all the space to be removed must be available in the 2K pool. You may need to move space to the 2K pool from other pools before you can reduce the size of the data cache. In the last example, if you wanted to reduce the size of the cache to 3MB, you would need to use **sp_poolconfig** to move some memory into the 2K pool from the 4K pool. See "Changing the Size of Memory Pools" on page 15-27 for more information.

Dropping Data Caches

To completely remove a data cache, reset its size to 0:

```
sp_cacheconfig pubs_log, "0"
```

This changes the cache status to "Pend/Del." You must restart Adaptive Server for the change to take effect. Until you do, the cache remains active, and all objects bound to the cache still use it for I/O.

If you delete a data cache, and there are objects bound to the cache, the cache bindings are marked invalid at the next restart of Adaptive Server. All objects with invalid cache bindings use the default data cache. Warning messages are printed in the error log when the bindings are marked invalid. For example, if the *titles* table in the *pubs2* database is bound to a cache, and that cache is dropped, the message in the log is:

```
Cache binding for database '5', object
'208003772', index '0' is being marked invalid in
Sysattributes.
```

If you re-create the cache and restart Adaptive Server, the bindings are marked valid again.

You cannot drop the default data cache.

Changing the Size of Memory Pools

To change the size of a memory pool, use **sp_poolconfig** to specify the cache, the new size for the pool, the I/O size of the pool you want to change, and the I/O size of the pool from which the buffers should be taken. If you do not specify the final parameter, all the space is taken from or assigned to the 2K pool.

Moving Space from the 2K Memory Pool

This command checks the current configuration of the *pubs_log* cache:

```
sp_cacheconfig pubs_log
```

```
Cache Name                Status    Type     Config Value Run Value
------------------------- --------- -------- ------------ ------------
pubs_log                  Active    Log Only      6.00 Mb      6.00 Mb
                                                ------------ ------------
                                      Total       6.00 Mb      6.00 Mb
===========================================================================
Cache: pubs_log,   Status: Active,   Type: Log Only
     Config Size: 6.00 Mb,   Run Size: 6.00 Mb
     Config Replacement: relaxed LRU,   Run Replacement: relaxed LRU
     Config Partition:            1,   Run Partition:            1

IO Size  Wash Size Config Size  Run Size     APF Percent
-------- --------- ------------ ------------ -----------
    2 Kb    716 Kb      0.00 Mb      3.50 Mb     10
    4 Kb    512 Kb      2.50 Mb      2.50 Mb     10
```

This command increases the size of the 4K pool to 5MB, moving the required space from the 2K pool:

```
sp_poolconfig pubs_log, "5M", "4K"
sp_cacheconfig pubs_log
```

```
Cache Name                Status    Type     Config Value Run Value
------------------------- --------- -------- ------------ ------------
pubs_log                  Active    Log Only      6.00 Mb      6.00 Mb
                                                ------------ ------------
                                      Total       6.00 Mb      6.00 Mb
============================================================================
Cache: pubs_log,   Status: Active,   Type: Log Only
     Config Size: 6.00 Mb,   Run Size: 6.00 Mb
     Config Replacement: relaxed LRU,   Run Replacement: relaxed LRU
     Config Partition:            1,   Run Partition:            1

IO Size  Wash Size Config Size  Run Size     APF Percent
-------- --------- ------------ ------------ -----------
    2 Kb    716 Kb      0.00 Mb      1.00 Mb     10
    4 Kb   1024 Kb      5.00 Mb      5.00 Mb     10
```

Moving Space from Other Memory Pools

To transfer space from a pool other than the 2K pool, you specify the cache name, a "to" I/O size, and a "from" I/O size. This output shows the current configuration of the default data cache:

```
Cache Name                Status    Type     Config Value Run Value
------------------------- --------- -------- ------------ ------------
default data cache        Active    Default      25.00 Mb     29.28 Mb
                                                ------------ ------------
                                      Total       25.00 Mb     29.28 Mb
============================================================================
Cache: default data cache,   Status: Active,   Type: Default
     Config Size: 25.00 Mb,   Run Size: 29.28 Mb
     Config Replacement: strict LRU,   Run Replacement: strict LRU
     Config Partition:            1,   Run Partition:            1

IO Size  Wash Size Config Size  Run Size     APF Percent
-------- --------- ------------ ------------ -----------
    2 Kb   3844 Kb      0.00 Mb     18.78 Mb     10
    4 Kb    512 Kb      2.50 Mb      2.50 Mb     10
   16 Kb   1632 Kb      8.00 Mb      8.00 Mb     10
```

The following command increases the size of the 4K pool from 2.5MB to 4MB, taking the space from the 16K pool:

```
sp_poolconfig "default data cache","4M", "4K","16K"
```

This command results in the following configuration:

```
Cache Name                Status    Type     Config Value Run Value
```

```
------------------------ --------- -------- ------------ ------------
default data cache       Active    Default      25.00 Mb     29.28 Mb
                                                ------------ ------------
                                     Total      25.00 Mb     29.28 Mb
===========================================================================
Cache: default data cache,   Status: Active,   Type: Default
     Config Size: 25.00 Mb,   Run Size: 29.28 Mb
     Config Replacement: strict LRU,   Run Replacement: strict LRU
     Config Partition:            1,   Run Partition:            1

IO Size  Wash Size Config Size  Run Size     APF Percent
-------- --------- ------------ ------------ -----------
    2 Kb   3844 Kb      0.00 Mb     18.78 Mb     10
    4 Kb    512 Kb      4.00 Mb      4.00 Mb     10
   16 Kb   1632 Kb      6.50 Mb      6.50 Mb     10
```

When you issue a command to move buffers between pools in a cache, Adaptive Server can move only "free" buffers. It cannot move buffers that are in use or buffers that contain changes that have not been written to disk.

When Adaptive Server cannot move as many buffers as you request, it displays an informational message, giving the requested size and the resulting size of the memory pool.

Adding Cache Partitions

On multi-engine servers, more than one task can attempt to access the cache at the same time. By default, each cache has a single spinlock, so that only one task can change or access the cache at a time. If cache spinlock contention is above 10%, increasing the number of cache partitions for a cache can reduce spinlock contention, and increase performance.

You can configure the number of cache partitions:

- For all data caches, using the configuration parameter **global cache partition number**
- For an individual cache, using **sp_cacheconfig**.

The number of partitions in a cache is always a power of 2 between 1 and 64. No pool in any cache partition can be smaller than 512K. In most cases, since caches may be sized to meet requirements for storing individual objects, you should use the local setting for the particular cache where spinlock contention is an issue.

See "Reducing Spinlock Contention with Cache Partitions" on page 32-18 of the *Performance and Tuning Guide* for information on choosing the number of partitions for a cache.

Setting the Number of Cache Partitions with sp_configure

To set the number of cache partitions for all caches on a server, use **sp_configure**. This command sets the number of cache partitions to 2:

```
sp_configure "global cache partition number",2
```

You must reboot the server for the change to take effect.

Setting the Number of Local Cache Partitions

Use **sp_cacheconfig** or the configuration file to set the number of local cache partitions. This command sets the number of cache partitions in the default data cache to 4:

```
sp_cacheconfig "default data cache",
"cache_partition=4"
```

You must reboot the server for the change to take effect.

Precedence

The local cache partition setting always takes precedence over the global cache partition value.

These commands set the server-wide partition number to 4, and the number of partitions for *pubs_cache* to 2:

```
sp_configure "global cache partition number", 4
sp_cacheconfig "pubs_cache", "cache_partition=2"
```

The local cache partition number takes precedence over the global cache partition number, so *pubs_cache* uses 2 partitions. All other configured caches have 4 partitions.

To remove the local setting for *pubs_cache*, and use the global value instead, use the command:

```
sp_cacheconfig "pubs_cache",
"cache_partition=default"
```

To reset the global cache partition number to the default, use:

```
sp_configure "global cache partition number", 0, "default"
```

Dropping a Memory Pool

To completely remove a pool, reset its size to 0. This command removes the 16K pool and places all space in the 2K pool:

```
sp_poolconfig "default data cache", "0",  "16K"
sp_cacheconfig "default data cache"
Cache Name               Status    Type     Config Value Run Value
------------------------ --------- -------- ------------ ------------
default data cache       Active    Default      25.00 Mb     29.28 Mb
                                              ------------ ------------
                                     Total      25.00 Mb     29.28 Mb
===========================================================================
Cache: default data cache,   Status: Active,   Type: Default
     Config Size: 25.00 Mb,   Run Size: 29.28 Mb
     Config Replacement: strict LRU,   Run Replacement: strict LRU
     Config Partition:            1,   Run Partition:            1

IO Size  Wash Size Config Size  Run Size     APF Percent
-------- --------- ------------ ------------ -----------
    2 Kb   3844 Kb      6.50 Mb     25.28 Mb     10
    4 Kb    512 Kb      4.00 Mb      4.00 Mb     10
```

If you do not specify the affected pool size (16K in the example above), all the space is placed in the 2K pool. You cannot delete the 2K pool in any cache.

When Pools Cannot Be Dropped Due to Pages Use

If the pool you are trying to delete contains pages that are in use, or pages that have been dirtied but not written to disk, Adaptive Server moves as many pages as possible to the specified pool and prints an informational message telling you the size of the remaining pool. If the pool size is smaller than the minimum allowable pool size, you also receive a warning message saying the pool has been marked unavailable. If you run **sp_cacheconfig** after receiving one of these warnings, the pool detail section for these pools contains an extra "Status" column, with either "Unavailable / too small" or "Unavailable / deleted" for the affected pool.

You can reissue the command at a later time to complete removing the pool. Pools with "Unavailable / too small" or "Unavailable / deleted" are also removed when you restart Adaptive Server.

Cache Binding Effects on Memory and Query Plans

Binding and unbinding objects may have an impact on performance. When you bind or unbind a table or an index:

- The object's pages are flushed from the cache.

- The object must be locked to perform the binding.
- All query plans for procedures and triggers must be recompiled.

Flushing Pages from Cache

When you bind an object or database to a cache, the object's pages that are already in memory are removed from the source cache. The next time the pages are needed by a query, they are read into the new cache. Similarly, when you unbind objects, the pages in cache are removed from the user-configured cache and read into the default cache the next time they are needed by a query.

Locking to Perform Bindings

To bind or unbind user tables, indexes, or text or image objects, the cache binding commands need an exclusive table lock on the object. If a user holds locks on a table, and you issue an **sp_bindcache**, **sp_unbindcache**, or **sp_unbindcache_all** on the object, the system procedure sleeps until it can acquire the locks it needs.

For databases, system tables, and indexes on system tables, the database must be in single-user mode, so there cannot be another user who holds a lock on the object.

Cache Binding Effects on Stored Procedures and Triggers

Cache bindings and I/O sizes are part of the query plan for stored procedures and triggers. When you change the cache binding for an object, all the stored procedures that reference the object are recompiled the next time they are executed. When you change the cache binding for a database, all stored procedures that reference any objects in the database that are not explicitly bound to a cache are recompiled the next time they are run.

Configuring Data Caches with the Configuration File

You can add or drop named data caches and reconfigure existing caches and their memory pools by editing the configuration file that is used when you start Adaptive Server.

➤ ***Note***

You cannot reconfigure caches and pools on a server while it is running by reading in a configuration file with **sp_configure**. Any attempt to read a configuration file that contains cache and pool configurations different from those already configured on the server causes the read to fail.

Cache and Pool Entries in the Configuration File

Each configured data cache on the server has this block of information in the configuration file:

```
[Named Cache:cache_name]
     cache size = {size | DEFAULT}
     cache status = {mixed cache | log only | default data cache}
     cache replacement policy = {DEFAULT |
         relaxed LRU replacement| strict LRU replacement }
```

Size units can be specified with:

- **P** – Pages, (Adaptive Server 2K pages)
- **K** – Kilobytes (default)
- **M** – Megabytes
- **G** – Gigabytes

This example shows the configuration file entry for the default data cache:

```
[Named Cache:default data cache]
      cache size = DEFAULT
      cache status = default data cache
      cache replacement policy = strict LRU replacement
```

The default data cache entry is the only cache entry that is required in order for Adaptive Server to start. It must have the cache size and cache status, and the status must be "default data cache."

If the cache has pools configured in addition to the 2K pool, the block in the preceding example is followed by a block of information for each pool:

```
[16K I/O Buffer Pool]
        pool size = size
        wash size = size
        local async prefetch limit = DEFAULT
```

➤ ***Note***

In some cases, there is no configuration file entry for the 2K pool in a cache. If you change the asynchronous prefetch percentage with **sp_poolconfig**, the change is not written to the configuration file, only to system tables.

This example shows output from **sp_cacheconfig**, followed by the configuration file entries that match this cache and pool configuration:

```
 Cache Name                Status    Type     Config Value Run Value
------------------------ --------- -------- ------------ ------------
default data cache       Active    Default      25.00 Mb     29.28 Mb
pubs_cache               Active    Mixed        20.00 Mb     20.00 Mb
pubs_log                 Active    Log Only      6.00 Mb      6.00 Mb
tempdb_cache             Active    Mixed         4.00 Mb      4.00 Mb
                                                ------------ ------------
                                     Total      55.00 Mb     59.28 Mb
===================================================================
Cache: default data cache,   Status: Active,   Type: Default
     Config Size: 25.00 Mb,   Run Size: 29.28 Mb
     Config Replacement: strict LRU,   Run Replacement: strict LRU
     Config Partition:            1,   Run Partition:            1

IO Size  Wash Size Config Size  Run Size     APF Percent
-------- --------- ------------ ------------ -----------
    2 Kb   3844 Kb      6.50 Mb     25.28 Mb     10
    4 Kb    512 Kb      4.00 Mb      4.00 Mb     10
===================================================================
Cache: pubs_cache,   Status: Active,   Type: Mixed
     Config Size: 20.00 Mb,   Run Size: 20.00 Mb
     Config Replacement: strict LRU,   Run Replacement: strict LRU
     Config Partition:            1,   Run Partition:            1

IO Size  Wash Size Config Size  Run Size     APF Percent
-------- --------- ------------ ------------ -----------
    2 Kb   2662 Kb      0.00 Mb     13.00 Mb     10
   16 Kb   1424 Kb      7.00 Mb      7.00 Mb     10
===================================================================
Cache: pubs_log,   Status: Active,   Type: Log Only
     Config Size: 6.00 Mb,   Run Size: 6.00 Mb
     Config Replacement: relaxed LRU,   Run Replacement: relaxed LRU
     Config Partition:            1,   Run Partition:            1

IO Size  Wash Size Config Size  Run Size     APF Percent
-------- --------- ------------ ------------ -----------
    2 Kb    716 Kb      0.00 Mb      1.00 Mb     10
```

```
    4 Kb   1024 Kb      5.00 Mb      5.00 Mb     10
-------------------------------------------------------------------------
Cache: tempdb_cache,   Status: Active,   Type: Mixed
     Config Size: 4.00 Mb,   Run Size: 4.00 Mb
     Config Replacement: strict LRU,   Run Replacement: strict LRU
     Config Partition:            1,   Run Partition:            1

IO Size  Wash Size Config Size  Run Size     APF Percent
-------- --------- ------------ ------------ -----------
    2 Kb    818 Kb      0.00 Mb      4.00 Mb     10
```

This is the matching configuration file information:

```
[Named Cache:default data cache]
        cache size = 25M
        cache status = default data cache
        cache replacement policy = DEFAULT
        local cache partition number = DEFAULT

[2K I/O Buffer Pool]
        pool size = 6656.0000k
        wash size = 3844 K
        local async prefetch limit = DEFAULT

[4K I/O Buffer Pool]
        pool size = 4.0000M
        wash size = DEFAULT
        local async prefetch limit = DEFAULT

[Named Cache:pubs_cache]
        cache size = 20M
        cache status = mixed cache
        cache replacement policy = strict LRU replacement
        local cache partition number = DEFAULT

[16K I/O Buffer Pool]
        pool size = 7.0000M
        wash size = DEFAULT
        local async prefetch limit = DEFAULT

[Named Cache:pubs_log]
        cache size = 6M
        cache status = log only
        cache replacement policy = relaxed LRU replacement
        local cache partition number = DEFAULT

[4K I/O Buffer Pool]
        pool size = 5.0000M
        wash size = DEFAULT
        local async prefetch limit = DEFAULT
```

```
[Named Cache:tempdb_cache]
        cache size = 4M
        cache status = mixed cache
        cache replacement policy = DEFAULT
        local cache partition number = DEFAULT
```

For more information about the configuration file, see Chapter 17, "Setting Configuration Parameters."

◆ ***WARNING!***

Check the total memory configuration parameter and allow enough memory for other Adaptive Server needs. If you attempt to assign too much memory to data caches in your configuration file, Adaptive Server will not start. If this occurs, edit the configuration file to reduce the amount of space in the data caches, or increase the total memory allocated to Adaptive Server. See Chapter 14, "Configuring Memory," for suggestions on monitoring cache sizes.

Configuration File Errors

If you edit your configuration file by hand, check the cache, pool, and wash sizes carefully. Certain configuration file errors can cause start-up failure:

- The total size of all of the caches cannot be greater than the amount of total memory, minus other Adaptive Server memory needs.
- The total size of the pools in any cache cannot be greater than the size of the cache.
- The wash size cannot be too small (less than 20% of the pool size, with a minimum of 10 buffers) and cannot be larger than 80% of the buffers in the pool.
- The default data cache status must be "default data cache," and the size must be specified, either as a numeric value or as "DEFAULT".
- The status and size for any cache must be specified.
- The pool size and wash size for all pools larger than 2K must be specified.

- The status of all user-defined caches must be “mixed cache” or “log only”.
- The cache replacement policy and the asynchronous prefetch percentage are optional, but, if specified, they must have correct parameters or “DEFAULT.”

In most cases, problems with missing entries are reported as “unknown format” errors on lines immediately following the entry where the size, status, or other information was omitted. Other errors provide the name of the cache where the error occurred and the type of error. For example, you see this error if the wash size for a pool is specified incorrectly:

```
The wash size for the 4k buffer pool in cache
pubs_cache has been incorrectly configured. It
must be a minimum of 10 buffers and a maximum of
80 percent of the number of buffers in the pool.
```

Cache Configuration Guidelines

User-definable caches are a performance feature of Adaptive Server. This chapter addresses only the mechanics of configuring caches and pools and binding objects to caches. Performance information and suggested strategies for testing cache utilization is addressed in Chapter 32, “Memory Use and Performance,” in the *Performance and Tuning Guide*. Here are some general guidelines:

- Make sure that your default data cache is large enough for all cache activity on unbound tables and indexes. All objects that are not explicitly bound to a cache use the default cache. This includes any unbound system tables in the user databases, the system tables in master, and any other objects that are not explicitly bound to a cache.
- During recovery, only the 2K memory pool of the default cache is active. Transactions logs are read into the 2K pool of the default cache. All transactions that must be rolled back or rolled forward must read data pages into the default data cache. If the default data cache is too small, it can slow recovery time.
- Do not “starve” the 2K pool in any cache. For many types of data access, there is no need for large I/O. For example, a simple query that uses an index to return a single row to the user might use 4 or 5 2K I/Os, and gain nothing from 16K I/O.
- Certain commands can perform only 2K I/O: **disk init**, certain **dbcc** commands, and **drop table. dbcc checktable** can perform large I/O,

and **dbcc checkdb** performs large I/O on tables and 2K I/O on indexes.

- For caches used by transaction logs, configure an I/O pool that matches the default log I/O size. This size is set for a database using **sp_logiosize**. The default value is 4K.
- Trying to manage every index and object and its caching can waste cache space. If you have created caches or pools that are not optimally used by the tables or indexes bound to them, they are wasting space and creating additional I/O in other caches.
- If *tempdb* is used heavily by your applications, bind it to its own cache. Note that you can bind only the entire *tempdb* database, you cannot bind individual objects from *tempdb*.
- For caches with high update and replacement rates, be sure that your wash size is large enough.
- On multi-CPU systems, spread your busiest tables and their indexes across multiple caches to avoid spinlock contention.
- Consider reconfiguring caches or the memory pools within caches to match changing workloads. Reconfiguring caches requires a restart of the server, but memory pool reconfiguration does not.

  For example, if your system performs mostly OLTP (online transaction processing) during most of the month, and has heavy DSS (decision-support system) activity for a few days, consider moving space from the 2K pool to the 16K pool for the high DSS activity and resizing the pools for OLTP when the DSS workload ends.

16 Managing Multiprocessor Servers

This chapter provides guidelines for administering Adaptive Server on a multiprocessor. Topics include:

Parallel Processing

Adaptive Server implements the Sybase Virtual Server Architecture™, which enables it to take advantage of the parallel processing feature of symmetric multiprocessing (SMP) systems. You can run Adaptive Server as a single process or as multiple, cooperating processes, depending on the number of CPUs available and the demands placed on the server machine. This chapter describes:

- The target machine architecture for the SMP Adaptive Server
- Adaptive Server architecture for SMP environments
- Adaptive Server task management in the SMP environment
- Managing multiple engines

For information on application design for SMP systems, see Chapter 37, "How Adaptive Server Uses Engines and CPUs," in the *Performance and Tuning Guide*.

Definitions

Here are the definitions for several terms used in this chapter:

- **Process** – an execution environment scheduled onto physical CPUs by the operating system.
- **Engine** – a process running an Adaptive Server that communicates with the other Adaptive Server processes via shared memory. An engine can be thought of as one CPU's worth of processing power. It does **not** represent a particular CPU. Also referred to as a **server engine**.

- **Task** – an execution environment within the Adaptive Server that is scheduled onto engines by the Adaptive Server.
- **Affinity** – describes a process in which a certain Adaptive Server task runs only on a certain engine (**task affinity**), a certain engine handles network I/O for a certain task (**network I/O affinity**), or a certain engine runs only on a certain CPU (**engine affinity**).
- **Network affinity migration** – describes the process of moving network I/O from one engine to another. SMP systems that support this migration allow Adaptive Server to distribute the network I/O load among all of its engines.

Target Architecture

The SMP environment product is intended for machines with the following features:

- A symmetric multiprocessing operating system
- Shared memory over a common bus
- 1–128 processors
- No master processor
- Very high throughput

Adaptive Server consists of one or more cooperating processes (called **engines**), all of which run the server program in parallel. See Figure 16-1.

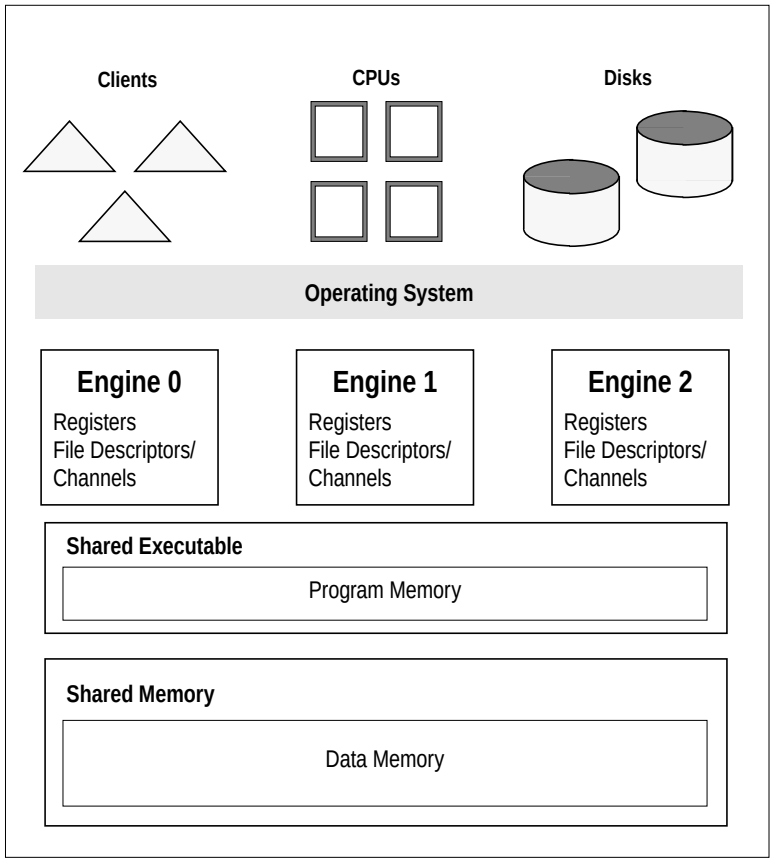

Figure 16-1: SMP environment architecture

When clients connect to Adaptive Server, the client connections are assigned to engines in a round-robin fashion, so all engines share the work of handling network I/O for clients. All engines are peers, and they communicate via shared memory.

The server engines perform all database functions, including updates and logging. Adaptive Server, not the operating system, dynamically schedules client tasks onto available engines.

The operating system schedules the engine processes onto physical processors. Any available CPU is used for any engine; there is no **engine affinity**. The processing is called **symmetric** because the lack of affinity between processes and CPUs creates a symmetrically balanced load.

Configuring an SMP Environment

Configuring the SMP environment is much the same as configuring the uniprocessor environment, although SMP machines are typically more powerful and handle many more users. The SMP environment provides the additional ability to control the number of engines.

Managing Engines

To achieve optimum performance from an SMP system, you must maintain the right number of engines.

An engine represents a certain amount of CPU power. It is a configurable resource like memory.

Resetting the Number of Engines

When you first install an Adaptive Server, the system is configured for a single engine. To use multiple engines, you must reset the number of engines the first time you restart the server. You may also want to reset the number of engines at other times.

For example:

- You might want to **increase** the number of engines if current performance is not adequate for an application **and** there are enough CPUs on the machine.
- You might want to **decrease** the number of engines if a hardware failure disables CPUs on the machine.

You must restart the server to reset the number of engines.

The **max online engines** configuration parameter controls the number of engines used by Adaptive Server. Reset this parameter **sp_configure**. For example, to set the number of engines to 3:

1. Issue the following command:

   ```
   sp_configure "max online engines", 3
   ```

2. Stop and restart the server.

Repeat these steps whenever you need to change the number of engines. Engines other than engine 0 are brought online after recovery is complete.

Choosing the Right Number of Engines

It is important that you choose the right number of engines for Adaptive Server. Here are some guidelines:

- **Never** have more engines than CPUs. Doing so may slow performance. If a CPU goes offline, use **sp_configure** to reduce the **max online engines** configuration parameter by 1 and restart Adaptive Server.
- Have only as many engines as you have **usable** CPUs. If there is a lot of processing by the client or other non-Adaptive Server processes, then one engine per CPU may be excessive. Remember, too, that the operating system may take up part of one of the CPUs.
- Have **enough** engines. It is good practice to start with a few engines and add engines when the existing CPUs are almost fully used. If there are too few engines, the capacity of the existing engines will be exceeded and bottlenecks may result.

Taking Engines Offline with *dbcc engine*

You can dynamically change the number of engines in use by Adaptive Server with the **dbcc engine** command to take an engine offline or bring an engine online. This allows a System Administrator to reconfigure CPU resources as processing requirements fluctuate over time.

Two configuration parameters limit the number of engines available to the server:

- **max online engines** – when the server is booted, the number of engines specified by **max online engines** are started. The number of engines can never exceed **max online engines.**
- **min online engines** – sets the minimum number of engines. When you take engines offline using **dbcc engine**, you cannot reduce the number of engines below the value set by **min online engines.**

Due to the operating system limit on the number of file descriptors per process, reducing the number of engines reduces the number of network connections that the server can have.

There is no way to migrate a network connection created for server-to-server remote procedure calls, for example, connections to Replication Server and XP Server, so you cannot take an engine offline that is managing one of these connections.

dbcc engine Syntax and Usage

The syntax for **dbcc engine** is:

```
dbcc engine(offline , [enginenum] )
dbcc engine("online")
```

If *enginenum* is not specified, the highest-numbered engine is taken offline.

Depending on your operating system and the load on Adaptive Server, taking an engine offline can take several minutes. To complete the task of taking an engine offline, the following steps must be completed:

- All outstanding I/Os for the engine must complete.
- All tasks affiliated with the engine must be migrated to other engines.
- Operating system and internal cleanup must de-allocate all structures.

If tasks cannot be migrated within approximately 5 minutes, the tasks are killed.

◆ ***WARNING!***

If you use dbcc engine(offline) when CPU utilization is high on the server, Adaptive Server may not be able to migrate all tasks before the time limit expires.Tasks that cannot be migrated within the time limit are killed.

Status and Messages During *dbcc engine(offline)*

When a System Administrator issues a **dbcc engine(offline)** command, messages are sent to the error log. For example, these are the messages on Sun Solaris:

```
00:00000:00000:1999/04/08 15:09:01.13 kernel
engine 5, os pid 19441  offline
```

dbcc engine(offline) returns immediately; you must monitor the error log or check the engine status in *sysengines* to know that the offline-engine task completes.

An engine with open network connections using Client Library cannot be taken offline. Attempting to offline the engine reports this message in the error log:

```
00:00000:00000:1999/04/08 15:30:42.47 kernel
ueoffline: engine 3 has outstanding ct-lib
connections and cannot be offlined.
```

If there are tasks that cannot be migrated to another engine within several minutes, the task is killed, and a message similar to this is sent to the error log:

```
00:00000:00000:1999/04/08 15:20:31.26 kernel
Process 57 is killed due to engine offline.
```

Monitoring Engine Status

Values in the *status* column of *sysengines* track the progress of **dbcc engine** commands:

- *online* – indicates the engine is online.
- *in offline* – indicates that **dbcc engine(offline)** has been run. The engine is still allocated to the server, but is in the process of having its tasks migrated to other engines.
- *in destroy* – indicates that all tasks have successfully migrated off the engine, and that the server is waiting on the OS level task to deallocate the engine.
- *in create* – indicates that an engine is in the process of being brought online.

The following command shows the engine number, status, number of tasks affinitied, and the time an engine was brought online:

```
select engine, status, affinitied, starttime
from sysengines
```

```
engine status       affinitied  starttime
------ ------------ ----------- -------------------------
     0 online                12        Mar  5 1999  9:40PM
     1 online                 9        Mar  5 1999  9:41PM
     2 online                12        Mar  5 1999  9:41PM
     3 online                14        Mar  5 1999  9:51PM
     4 online                 8        Mar  5 1999  9:51PM
     5 in offline            10        Mar  5 1999  9:51PM
```

Logical Process Management and *dbcc engine(offline)*

If you are using logical process management to bind particular logins or applications to engine groups, use **dbcc engine(offline)** carefully. If you offline all engines for an engine group:

- The login or application can run on any engine

- An advisory message is sent to the connection logging in to the server

Since engine affinity is assigned when a client logs in, users who are already logged in are not migrated if the engines in the engine group are brought online again with **dbcc engine("online").**

Monitoring CPU Usage

To maintain the correct number of engines, monitor CPU usage with an operating system utility. See the configuration documentation for your platform for the appropriate utility for your operating system.

Managing User Connections

If the SMP system supports network affinity migration, each engine handles the network I/O for its connections. During login, Adaptive Server migrates the client connection task from engine 0 to the engine currently servicing the smallest number of connections. The client's tasks run network I/O on that engine (**network affinity**) until the connection is terminated. To determine if your SMP system supports this migration, see the configuration documentation for your platform.

By distributing the network I/O among its engines, Adaptive Server can handle more user connections. The per-process limit on the maximum number of open file descriptors no longer limits the number of connections. Adding more engines linearly increases the maximum number of file descriptors, as stored in the global variable *@@max_connections*.

As you increase the number of engines, Adaptive Server prints the increased *@@max_connections* value to standard output and the error log file after you restart the server. You can query the value as follows:

```
select @@max_connections
```

This number represents the maximum number of file descriptors allowed by the operating system for your process, minus these file descriptors used by Adaptive Server:

- One for each master network listener on engine 0 (one for every "master" line in the interfaces file entry for that Adaptive Server)
- One for each engine's standard output
- One for each engine's error log file

- Two for each engine's network affinity migration channel
- One per engine for configuration
- One per engine for the interfaces file
- One per engine for internal use (OpenVMS only)

For example, if Adaptive Server is configured for one engine, and the value of *@@max_connections* equals 1019, adding a second engine increases the value of *@@max_connections* to 2039 (assuming only one master network listener).

You can configure the **number of user connections** parameter to take advantage of an increased *@@max_connections* limit. However, each time you decrease the number of engines using **max online engines**, you must also adjust the **number of user connections** value accordingly. Reconfiguring **max online engines** or **number of user connections** is not dynamic, so you must restart the server to change these configuration values. For information about configuring **number of user connections**, see Chapter 17, "Setting Configuration Parameters."

Managing Memory

The **total memory** configuration parameter may require special attention in SMP sites.

Not all platforms require a higher memory configuration parameter than before Adaptive Server version 11.5. If your platform does, the installed value of the **total memory** configuration parameter reflects this, so you may never need to adjust it. If error message 701:

```
There is insufficient memory to run this query
```

appears in the error log and at the client terminal, you may want to increase the amount of procedure cache available.

Configuration Parameters That Affect SMP Systems

Chapter 17, "Setting Configuration Parameters," lists configuration parameters for Adaptive Server. Some of those parameters, such as spinlock ratios, are applicable only to SMP systems.

Configuring Spinlock Ratio Parameters

Spinlock ratio parameters specify the number of internal system resources such as rows in an internal table or cache that are protected

by one **spinlock**. A spinlock is a simple locking mechanism that prevents a process from accessing the system resource currently used by another process. All processes trying to access the resource must wait (or "spin") until the lock is released.

Spinlock ratio configuration parameters are meaningful only in multiprocessing systems. An Adaptive Server configured with only one engine has only one spinlock, regardless of the value specified for a spinlock ratio configuration parameter.

Table 16-1 lists system resources protected by spinlocks and the configuration parameters you can use to change the default spinlock ratio.

Table 16-1: Spinlock ratio configuration parameters

Configuration Parameter	System Resource Protected
lock spinlock ratio	Number of lock hash buckets
open index hash spinlock ratio	Index metadata descriptor hash tables
open index spinlock ratio	Index metadata descriptors
open object spinlock ratio	Object metadata descriptors
partition spinlock ratio	Rows in the internal partition caches
user log cache spinlock ratio	User log caches

The value specified for a spinlock ratio parameter defines the ratio of the particular resource to spinlocks, not the number of spinlocks. For example, if 100 is specified for the spinlock ratio, Adaptive Server allocates one spinlock for each 100 resources. The number of spinlocks allocated by Adaptive Server depends on the total number of resources as well as on the ratio specified. The lower the value specified for the spinlock ratio, the higher the number of spinlocks.

Spinlocks are assigned to system resources in one of two ways:

- Round-robin assignment
- Sequential assignment

Round-Robin Assignment

Metadata cache spinlocks (configured by the **open index hash spinlock ratio**, **open index spinlock ratio**, and **open object spinlock ratio** parameters) use the round-robin assignment method.

Figure 16-2 illustrates one example of the round-robin assignment method and shows the relationship between spinlocks and index metadata descriptors.

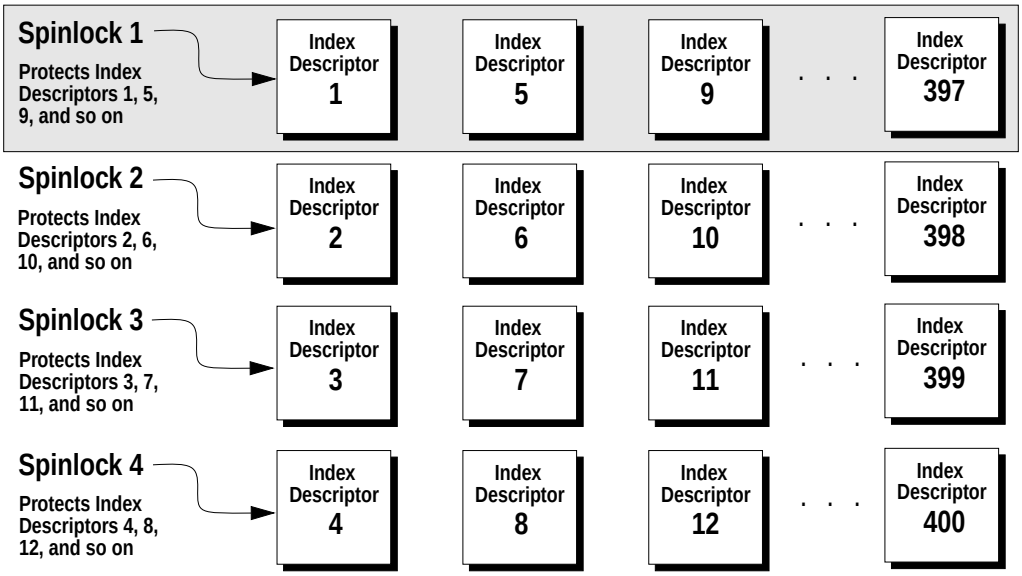

Figure 16-2: Relationship between spinlocks and index descriptors

Suppose there are 400 index metadata descriptors, or 400 rows in the index descriptors internal table. You have set the ratio to 100. This means that there will be 4 spinlocks in all: Spinlock 1 protects row 1; Spinlock 2 protects row 2, Spinlock 3 protects row 3, and Spinlock 4 protects row 4. After that, Spinlock 1 protects the next available index descriptor, Index Descriptor 5, until every index descriptor is protected by a spinlock. This round-robin method of descriptor assignment reduces the chances of spinlock contention.

Sequential Assignment

Table lock spinlocks, configured by the **table lock spinlock ratio** parameter, use the sequential assignment method. The default configuration for table lock spinlock ratio is 20, which assigns 20 rows in an internal hash table to each spinlock. The rows are divided up sequentially: the first spinlock protects the first 20 rows, the second spinlock protects the second 20 rows, and so on.

In theory, protecting one resource with one spinlock would provide the least contention for a spinlock and would result in the highest concurrency. In most cases, the default value for these spinlock ratios is probably best for your system. Change the ratio only if there is spinlock contention.

Use **sp_sysmon** to get a report on spinlock contention. See the *Performance and Tuning Guide* for information on spinlock contention.

Configuring Server Behavior

17 Setting Configuration Parameters

This chapter describes the Adaptive Server configuration parameters. A configuration parameter is a user-definable setting that you set with the system procedure **sp_configure**. Configuration parameters are used for a wide range of services, from basic to specific server operations, and for performance tuning.

Adaptive Server Configuration Parameters

The following table lists the Adaptive Server configuration parameters alphabetically.

Configuration Parameters
abstract plan cache, page 17-114
abstract plan dump, page 17-114
abstract plan load, page 17-115
abstract plan replace, page 17-115
additional network memory, page 17-107
allow backward scans, page 17-116
allow nested triggers, page 17-117
allow procedure grouping, page 17-154
allow remote access, page 17-89
allow resource limits, page 17-117
allow sendmsg, page 17-89
allow sql server async i/o, page 17-38
allow resource limits, page 17-117
allow updates to system tables, page 17-118
auditing, page 17-155
audit queue size, page 17-155
cis bulk insert batch size, page 17-34
cis connect timeout, page 17-34
cis cursor rows, page 17-35
cis packet size, page 17-35

Configuration Parameters (continued)
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configuration file, page 17-60
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current audit table, page 17-156
deadlock checking period, page 17-68
deadlock retries, page 17-69
default character set id, page 17-63
default database size, page 17-121
default exp_row_size percent, page 17-123
default fill factor percent, page 17-122
default language id, page 17-63
default network packet size, page 17-90
default sortorder id, page 17-64
disable character set conversions, page 17-64
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dtm detach timeout period, page 17-43
dtm lock timeout period, page 17-44
dump on conditions, page 17-124
enable cis, page 17-36
enable DTM, page 17-46
enable housekeeper GC, page 17-128
enable HA, page 17-128
enable java, page 17-61
enable rep agent threads, page 17-113
enable sort-merge joins and JTC, page 17-124
enable unicode conversion, page 17-65
enable xact coordination, page 17-47
esp execution priority, page 17-56
esp execution stacksize, page 17-57
esp unload dll, page 17-57

Configuration Parameters (continued)
event buffers per engine, page 17-125
event log computer name (Windows NT Only), page 17-53
event logging (Windows NT Only), page 17-54
executable codesize + overhead, page 17-79
freelock transfer block size, page 17-71
global async prefetch limit, page 17-28
global cache partition number, page 17-28
housekeeper free write percent, page 17-126
i/o accounting flush interval, page 17-131
i/o polling process count, page 17-132
identity burning set factor, page 17-129
identity grab size, page 17-130
license information, page 17-153
lock address spinlock ratio, page 17-66
lock hashtable size, page 17-75
lock shared memory, page 17-108
lock scheme, page 17-76
lock spinlock ratio, page 17-74
lock wait period, page 17-76
log audit logon failure, page 17-55
log audit logon success, page 17-55
max async i/os per engine, page 17-99
max async i/os per server, page 17-99
max engine freelocks, page 17-72
max cis remote connections, page 17-37
max cis remote servers, page 17-38
max network packet size, page 17-91
max number network listeners, page 17-94
max online engines, page 17-111
max parallel degree, page 17-104
max roles enabled per user, page 17-157

Configuration Parameters (continued)
max scan parallel degree, page 17-105
max SQL text monitored, page 17-109
memory alignment boundary, page 17-29
memory per worker process, page 17-106
min online engines, page 17-112
msg confidentiality reqd, page 17-158
msg integrity reqd, page 17-158
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number of devices, page 17-41
number of dtx participants, page 17-48
number of index trips, page 17-30
number of languages in cache, page 17-66
number of large i/o buffers, page 17-23
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number of open databases, page 17-80
number of open indexes, page 17-82
number of open objects, page 17-84
number of pre-allocated extents, page 17-141
number of remote connections, page 17-94
number of remote logins, page 17-95
number of remote sites, page 17-95
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number of user connections, page 17-164
number of worker processes, page 17-104
open index hash spinlock ratio, page 17-86
open index spinlock ratio, page 17-87
open object spinlock ratio, page 17-88

Configuration Parameters (continued)
o/s file descriptors, page 17-101
page lock promotion HWM, page 17-133
page lock promotion LWM, page 17-134
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partition groups, page 17-142
partition spinlock ratio, page 17-143
permission cache entries, page 17-166
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procedure cache percent, page 17-32
read committed with lock, page 17-77
recovery interval in minutes, page 17-24
remote server pre-read packets, page 17-96
row lock promotion HWM, page 17-151
row lock promotion LWM, page 17-152
row lock promotion PCT, page 17-153
runnable process search count, page 17-145
secure default login, page 17-159
select on syscomments.text column, page 17-160
shared memory starting address, page 17-102
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Configuration Parameters (continued)
strict dtm enforcement, page 17-49
suspend audit when device full, page 17-160
syb_sendmsg port number, page 17-97
systemwide password expiration, page 17-161
lock table spinlock ratio, page 17-78
tape retention in days, page 17-27
tcp no delay, page 17-98
text prefetch size, page 17-149
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user log cache size, page 17-171
user log cache spinlock ratio, page 17-172
use security services (Windows NT Only), page 17-163
xact coordination interval, page 17-52
xp_cmdshell context, page 17-59

What Are Configuration Parameters?

Configuration parameters are user-definable settings that control various aspects of Adaptive Server's behavior. Adaptive Server supplies default values for all configuration parameters. You can use configuration parameters to tailor Adaptive Server for an installation's particular needs.

Read this chapter carefully to determine which configuration parameters you should reset to optimize server performance. Also, see the *Performance and Tuning Guide* for further information on using **sp_configure** to tune Adaptive Server.

◆ ***WARNING!***

Change configuration parameters with caution. Arbitrary changes in parameter values can adversely affect Adaptive Server performance and other aspects of server operation.

The Adaptive Server Configuration File

Adaptive Server stores the values of configuration parameters in a configuration file, which is an ASCII text file. When you install a new Adaptive Server, your parameters are set to the default configuration; the default name of the file is *server_name.cfg*, and the default location of the file is the Sybase installation directory ($SYBASE). When you change a configuration parameter, Adaptive Server saves a copy of the old configuration file as *server_name.001*, *server_name.002*, and so on. Adaptive Server writes the new values to the file *server_name.cfg* or to a file name you specify at start-up.

How to Modify Configuration Parameters

You set or change configuration parameters in one of the following ways:

- By executing the system procedure **sp_configure** with the appropriate parameters and values,
- By editing your configuration file and then invoking **sp_configure** with the **configuration file** option, or
- By specifying the name of a configuration file at start-up.

Configuration parameters are either **dynamic** or **static**. Dynamic parameters go into effect as soon as you execute **sp_configure**. Static parameters require Adaptive Server to reallocate memory, so they take effect only after Adaptive Server has been restarted. The description of each parameter indicates whether it is static or dynamic. Adaptive Server writes the new value to the system table *sysconfigures* and to the configuration file when you change the value, not when you restart Adaptive Server. The current configuration file and *sysconfigures* reflect configured values, not run values. The system table *syscurconfigs* reflects current run values of configuration parameters.

Who Can Modify Configuration Parameters

The roles required for using **sp_configure** are as follows:

- Any user can execute **sp_configure** to display information about parameters and their current values.
- Only a System Administrator and System Security Officer can execute **sp_configure** to modify configuration parameters.
- Only a System Security Officer can execute **sp_configure** to modify values for:

- **allow procedure grouping**
- **allow updates to system tables**
- **auditing**
- **audit queue size**
- **current audit table**
- **max roles enabled per user**
- **msg confidentiality reqd**
- **msg integrity reqd**
- **allow procedure grouping**
- **allow updates to system tables**
- **auditing**
- **audit queue size**
- **current audit table**
- **max roles enabled per user**
- **allow remote access**
- **allow remote access**
- **secure default login**
- **select on syscomments.text column**
- **suspend audit when device full**
- **systemwide password expiration**
- **unified login required (Windows NT Only)**
- **use security services (Windows NT Only)**
- **secure default login**
- **select on syscomments.text column**
- **suspend audit when device full**
- **systemwide password expiration**
- **unified login required (Windows NT Only)**
- **use security services (Windows NT Only)**

Getting Help Information on Configuration Parameters

Use either **sp_helpconfig** or **sp_configure** to get information on a particular configuration parameter. For example:

```
sp_helpconfig "number of open"
```

```
              Configuration option is not unique.
option_name                    config_value run_value
------------------------------ ------------ -----------
number of open databases                 12          12
number of open indexes                  500         500
number of open objects                  500         500
```

```
              sp_helpconfig "number of open indexes"
number of open indexes sets the maximum number of indexes that can be
open at one time on SQL Server. The default value is 500.
Minimum Value Maximum Value Default Value Current Value Memory Used
------------- ------------- ------------- ------------- -----------
          100    2147483647           500           500         208
```

```
              sp_configure "number of open indexes"
Parameter Name           Default  Memory Used  Config Value  Run Value
-----------------------  -------  -----------  ------------  ---------
number of open indexes       500          208           500        500
```

For more information, see “Using sp_helpconfig to Get Help on Configuration Parameters” on page 14-6.

Using *sp_configure*

sp_configure displays and resets configuration parameters. You can restrict the number of parameters displayed by **sp_configure** using **sp_displaylevel** to set your display level to one of three values:

- Basic
- Intermediate
- Comprehensive

For information about display levels, see “User-Defined Subsets of the Parameter Hierarchy: Display Levels” on page 17-18. For information about **sp_displaylevel**, see the *Adaptive Server Reference Manual*.

Table 17-1 describes the syntax for **sp_configure**. The information in the "Effect" column assumes that your display level is set to "comprehensive."

Table 17-1: sp_configure syntax

Command	Effect
sp_configure	Displays all configuration parameters by group, their current values, their default values, the value to which they have most recently been set, and the amount of memory used by this particular setting.
sp_configure "*parameter***"**	Displays current value, default value, most recently changed value, and amount of memory used by setting for all parameters matching parameter.
sp_configure "*parameter***",** *value*	Resets *parameter* to *value*.
sp_configure "*parameter***", *0*, "default"**	Resets parameter to its default value.
sp_configure "*group_name***"**	Displays all configuration parameters in *group_name*, their current values, their default values, the values to which they were recently set, and the amount of memory used by each setting.
sp_configure "**configuration file**", 0, "*sub_command*", "*file_name*"	Sets configuration parameters from the configuration file. See "Using sp_configure with a Configuration File" on page 17-11 for descriptions of the parameters.

Syntax Elements

In Table 17-1 the following variables are used:

- *parameter* – is any valid Adaptive Server configuration parameter or parameter substring.
- *value* – is any integer within the valid range for that parameter. (See the descriptions of the individual parameters for valid range information.) Parameters that are toggles have only two valid values: 1 (on) and 0 (off).
- *group_name* – is the name of any group in the parameter hierarchy.

Parameter Parsing

sp_configure parses each parameter (and parameter name fragment) as "*%parameter%*". A string that does not uniquely identify a particular parameter returns values for all parameters matching the string. For example:

```
sp_configure "lock"
```

returns values for all configuration parameters that include "lock," such as **lock shared memory**, **number of locks**, **lock promotion HWM**, **server clock tick length**, **print deadlock information**, and **deadlock retries**.

➤ ***Note***

If you attempt to set a parameter value with a nonunique parameter name fragment, **sp_configure** returns the current values for all parameters matching the fragment and asks for a unique parameter name.

Using *sp_configure* with a Configuration File

You can configure Adaptive Server either interactively, by using **sp_configure** as described above, or noninteractively, by instructing Adaptive Server to read values from an edited or restored version of the configuration file.

The benefits of using onfiguration files include:

- You can replicate a specific configuration across multiple servers by using the same configuration file.
- You can use a configuration file as a baseline for testing configuration values on your server.
- You can use a configuration file to do validation checking on parameter values before actually setting the values.
- You can create multiple configuration files and switch between them as your resource needs change.

You can make a copy of the configuration file using **sp_configure** with the parameter "**configuration file**" and then edit the file at the operating system level. Then, you can use **sp_configure** with the parameter "**configuration file**" to instruct Adaptive Server to read values from the edited file. Or you can specify the name of the configuration file at start-up.

For information on editing the file, see “Editing the Configuration File” on page 17-14. For information on specifying the name of the configuration file at start-up, see “Starting Adaptive Server with a Configuration File” on page 17-15.

Naming Tips for the Configuration File

Each time you modify a configuration parameter with **sp_configure**, Adaptive Server creates a copy of the outdated configuration file, using the naming convention *server_name.001*, *server_name.002*, *server_name.003*...*server_name.999*.

If you want to work with a configuration file with a name other than the default name, and you keep the *server_name* part of the file name, be sure to include at least one alphabetic character in the extension. Alternatively, you can change the *server_name* part of the file name. Doing this avoids confusion with the backup configuration files generated by Adaptive Server when you modify a parameter.

Using *sp_configure* to Read or Write the Configuration File

The syntax for using the **configuration file** option with **sp_configure** is:

```
sp_configure "configuration file", 0, "subcommand",
   "file_name"
```

where:

- “configuration file” (include quotes) specifies the configuration file parameter.
- 0 must be included as the second parameter to **sp_configure** for backward compatibility.
- “*subcommand*” is one of the commands described below.
- *file_name* specifies the configuration file you want to use in conjunction with any *subcommand*. If you do not specify a directory as part of the file name, the directory where Adaptive Server was started is used.

Parameters for Using Configuration Files

The four parameters described below can be used with configuration files.

write

write creates *file_name* from the current configuration. If *file_name* already exists, a message is written to the error log; the existing file is renamed using the convention *file_name.001*, *file_name.002*, and so on. If you have changed a static parameter, but you have not restarted your server, **write** gives you the **currently running value** for that parameter. If you do not specify a directory with *file_name*, the file is written to the directory from which Adaptive Server was started.

read

read performs validation checking on values contained in *file_name* and reads those values that pass validation into the server. If any parameters are missing from *file_name*, the current values for those parameters are used.

If the value of a static parameter in *file_name* is different from its current running value, **read** fails and a message is printed. However, validation is still performed on the values in *file_name*.

verify

verify performs validation checking on the values in *file_name*. This is useful if you have edited the configuration file, as it prevents you from attempting to configure your server with invalid configuration values.

restore

restore creates *file_name* with the most recently configured values. If you have configured static parameters to new values, this subcommand will write the configured, not the currently running, values to the file. This is useful if all copies of the configuration file have been lost and you need to generate a new copy. If you do not specify a directory with *file_name*, the file is written to the directory from which Adaptive Server was started.

Examples

This example performs validation checking on the values in the file *srv.config* and reads the parameters that pass validation into the server. Current run values are substituted for values that do not pass validation checking.

```
sp_configure "configuration file", 0, "read",
"srv.config"
```

This example creates the file *my_server.config* and writes the current configuration values the server is using to that file.

```
sp_configure "configuration file", 0, "write",
"my_server.config"
```

This example runs validation checking on the values in the file *generic.config*.

```
sp_configure "configuration file", 0, "verify",
"generic.config"
```

This example writes configured values to the file *restore.config*.

```
sp_configure "configuration file", 0, "restore",
"restore.config"
```

Editing the Configuration File

The configuration file is an operating system ASCII file that you can edit with any text editor that can save files in ASCII format. The syntax for each parameter is:

```
parameter_name={value | DEFAULT}
```

where *parameter_name* is the name of the parameter you want to specify, *value* is the numeric value for set *parameter_name*, and "DEFAULT" specifies that you want to use the default value for *parameter_name*.

Examples:

```
deadlock retries = 1
```

specifies that the transaction can retry to acquire a lock one time when deadlocking occurs during an index page split or shrink.

```
cpu accounting flush interval=DEFAULT
```

specifies that the default value for the parameter **cpu accounting flush interval** should be used.

When you edit a configuration file, your edits are not validated until you check the file using the **verify** option, read the file with the **read** option, or restart Adaptive Server with that configuration file.

If all your configuration files are lost or corrupted, you can re-create one from a running server by using the **restore** subcommand and specifying a name for the new file. The parameters in the new file will be set to the values with which your server is currently running.

Permissions for Configuration Files

Configuration files are nonencrypted ASCII text files. By default, they are created with read and write permissions set for the file owner and read permission set for all other users. If you created the configuration file at the operating system level, you are the file owner; if you created the configuration file from Adaptive Server, using the **write** or **restore** parameter, the file owner is the user who started Adaptive Server. Usually, this is the user "sybase." To restrict access to configuration files, use your operating system's file permission command to set read, write, and execute permissions as appropriate.

➤ ***Note***

You need to set permissions accordingly on **each** configuration file created.

Backing Up Configuration Files

Configuration files are not automatically backed up when you back up the *master* database. They are operating system files, and you should back them up in the same way you back up your other operating system files.

Checking the Name of the Configuration File Currently in Use

The output from **sp_configure** truncates the name of the configuration file due to space limitations. To see the full name of the configuration file, use:

```
select s1.value2
from syscurconfigs s1, sysconfigures s2
where s1.config = s2.config
and s2.name = "configuration file"
```

Starting Adaptive Server with a Configuration File

By default, Adaptive Server reads the configuration file *server_name.cfg* in the start-up directory when it starts. If this file does not exist, it creates a new file and uses Adaptive Server defaults for all values.

You can start Adaptive Server with a specified configuration file. For more information, see the *Utility Programs* manual for your platform.

If the configuration file you specify does not exist, Adaptive Server prints an error message and does not start.

If the command is successful, the file *server_name.bak* is created. This file contains the configuration values stored in *sysconfigures* prior to the time *sysconfigures* was updated with the values read in from the configuration file you specified. This file is overwritten with each subsequent start-up.

Configuration File Errors

When there are errors in the configuration file, Adaptive Server may not start or may use default values.

Adaptive Server uses default values if:

- There are illegal values. For example, if a parameter requires a numeric value, and the configuration file contains a character string, Adaptive Server uses the default value.
- Values are below the minimum allowable value.

The Parameter Hierarchy

Configuration parameters are grouped according to the area of Adaptive Server behavior they affect. This makes it easier to identify all parameters that you might need to tune improve a particular area of Adaptive Server performance.

The groups are:

- Backup and Recovery
- Cache Manager
- Component Integration Services Administration
- Disk I/O
- DTM Administration
- Error Log
- Extended Stored Procedures
- General Information
- Java Services
- Languages
- Lock Manager
- Memory Use

- Metadata Caches
- Network Communication
- O/S Resources
- Parallel Queries
- Physical Memory
- Processors
- Rep Agent Thread Administration
- SQL Server Administration
- Security Related
- User Environment

Although each parameter has a primary group to which it belongs, many have secondary groups to which they also belong. For instance, **number of remote connections** belongs primarily to the Network Communication group, but it also belongs secondarily to the Adaptive Server Administration group and the Memory Use group. This reflects the fact that some parameters have implications for a number of areas of Adaptive Server behavior. **sp_configure** displays parameters in all groups to which they belong.

The syntax for displaying all groups and their associated parameters, and the current values for the parameters, is:

```
sp_configure
```

➤ *Note*

The number of parameters **sp_configure** returns depends on the value to which you have your display level set. See "User-Defined Subsets of the Parameter Hierarchy: Display Levels" on page 17-18 for further information about display levels.

The syntax for displaying a particular group and its associated parameter is:

```
sp_configure "group_name"
```

where *group_name* is the name of the group you are interested in. For example, to display the Disk I/O group, type:

```
sp_configure "Disk I/O"
```

```
Group: Disk I/O

Parameter Name           Default Memory Used Config Value Run Value
--------------           ------- ----------- ------------  ---------
allow sql server async i/o     1           0             1         1
disk i/o structures          256           0           256       256
number of devices             10           0            10        10
page utilization percent      95           0            95        95
```

➤ ***Note***

If the server uses a case-insensitive sort order, **sp_configure** with no parameters returns a list of all configuration parameters and groups in alphabetical order with no grouping displayed.

User-Defined Subsets of the Parameter Hierarchy: Display Levels

Depending on your use of Adaptive Server, you may need to adjust some parameters more frequently than others. You may find it is easier to work with a subset of parameters than having to see the entire group when you are working with only a few. You can set your display level to one of three values to give you the subset of parameters that best suits your working style.

The default display level is "comprehensive." When you set your display level, the setting persists across multiple sessions. However, you can reset it at any time to see more or fewer configuration parameters.

- "Basic" shows just the most basic parameters. It is appropriate for very general server tuning.
- "Intermediate" shows you parameters that are somewhat more complex, in addition to the "basic" parameters. This level is appropriate for a moderately complex level of server tuning.
- "Comprehensive" shows you all the parameters, including the most complex ones. This level is appropriate for users doing highly detailed server tuning.

The syntax for showing your current display level is:

```
sp_displaylevel
```

The syntax for setting your display level is:

```
sp_displaylevel user_name [, basic | intermediate |
   comprehensive]
```

where *user_name* is your Adaptive Server login name.

The Effect of the Display Level on *sp_configure* Output

If your display level is set to either "basic" or "intermediate," **sp_configure** returns only a subset of the parameters that are returned when your display level is set to "comprehensive." For instance, if your display level is set to "intermediate," and you want to see the parameters in the Languages group, type:

```
sp_configure "Languages"
```

The output would look like this:

```
Group: Languages

Parameter Name               Default Memory Used Config Value Run Value
---------------------------- ------- ----------- ------------ ---------
default character set id           1           0            1         1
default language id                0           0            0         0
number of languages in cache       3           4            3         3
```

However, this is only a subset of the parameters in the Languages group, because some parameters in that group are displayed only at the "comprehensive" level.

The *reconfigure* Command

Pre-11.0 SQL Server releases required you to execute **reconfigure** after executing **sp_configure**. Beginning with SQL Server release 11.0, this was longer required. The **reconfigure** command still exists, but it does not have any effect. It is included in Adaptive Server release 11.5 so you can run pre-11.0 SQL scripts without modification.

Scripts using **reconfigure** will still run in the current release, but you should change them at your earliest convenience because **reconfigure** will not be supported in future releases of Adaptive Server.

Performance Tuning with *sp_configure* and *sp_sysmon*

sp_sysmon monitors Adaptive Server performance and generates statistical information that describes the behavior of your Adaptive Server system. See the *Performance and Tuning Guide* for more information.

You can run **sp_sysmon** before and after using **sp_configure** to adjust configuration parameters. The output gives you a basis for

performance tuning and lets you observe the results of configuration changes.

This chapter includes cross-references to the *Performance and Tuning Guide* for the **sp_configure** parameters that can affect Adaptive Server performance.

Output from *sp_configure*

The sample output below shows the kind of information **sp_configure** prints if you have your display level set to "comprehensive" and you execute it with no parameters. The values it prints will vary, depending on your platform and on what values you have already changed.

```
sp_configure

Group: General Information
Parameter Name       Default Memory Used Config Value Run Value
--------------       ------- ----------- ------------ ---------
configuration file         0           0            0 /remote/pub

Group: Backup/Recovery

Parameter Name         Default Memory Used Config Value Run Value
--------------         ------- ----------- ------------ ---------
recovery interval in minutes 5           0            5         5
tape retention in days       0           0            0         0
recovery flags               0           0           0        0

...
```

➤ ***Note***

All configuration groups and parameters will appear in output if your display level is set to "comprehensive."

The "Default" column displays the value Adaptive Server is shipped with. If you do not explicitly reconfigure a parameter, it retains its default value.

The "Memory Used" column displays the amount of memory used (in kilobytes) by the parameter at its current value. Some related parameters draw from the same memory pool. For instance, the memory used for **stack size** and **stack guard size** is already accounted for in the memory used for **number of user connections**. If you added the memory used by each of these parameters separately, it would total

more than the amount actually used. In the "Memory Used" column, parameters that "share" memory with other parameters are marked with a hash mark ("#").

The "Config Value" column displays the most recent value to which the configuration parameter has been set. When you execute **sp_configure** to modify a dynamic parameter:

- The configuration and run values are updated.
- The configuration file is updated.
- The change takes effect immediately.

When you modify a static parameter:

- The configuration value is updated.
- The configuration file is updated.
- The change takes effect only when you restart Adaptive Server.

The "Run Value" column displays the value Adaptive Server is currently using. It changes when you modify a dynamic parameter's value with **sp_configure** and, for static parameters, after you restart Adaptive Server.

The *sysconfigures* and *syscurconfigs* Tables

The report displayed by **sp_configure** is constructed mainly from the *master..sysconfigures* and *master..syscurconfigs* system tables, with additional information coming from *sysattributes*, *sysdevices*, and other system tables.

The *value* column in the *sysconfigures* table records the last value set from **sp_configure** or the configuration file; the *value* column in *syscurconfigs* stores the value currently in use. For dynamic parameters, the two values match; for static parameters, which require a restart of the server to take effect, the two values are different if the values have been changed since Adaptive Server was last started. The values may also be different when the default values are used. In this case, *sysconfigures* stores 0, and *syscurconfigs* stores the value that Adaptive Server computes and uses.

sp_configure performs a join on *sysconfigures* and *syscurconfigs* to display the values reported by **sp_configure**.

Querying *syscurconfigs* and *sysconfigures*: An Example

You might want to query *sysconfigures* and *syscurconfigs* to get information organized the way you want. For example, **sp_configure** without any arguments lists the memory used for configuration parameters, but it does not list minimum and maximum values. You can query these system tables to get a complete list of current memory usage, as well as minimum, maximum, and default values, with the following query:

```
select b.name, memory_used, minimum_value,
maximum_value, defvalue
from master.dbo.sysconfigures b,
master.dbo.syscurconfigs c
where b.config *= c.config and parent != 19
and b.config > 100
```

Details on Configuration Parameters

The following sections give both summary and detailed information about each of the configuration parameters. Parameters are listed by group; within each group, they are listed alphabetically.

In many cases, the maximum allowable values for configuration parameters are extremely high. The maximum value for your server is usually limited by available memory, rather than by **sp_configure** limitations.

Renamed Configuration Parameters

The following configuration parameters have been renamed:

Old Name	New Name	See
lock promotion HWM	**page lock promotion HWM**	page lock promotion HWM, page 17-133
lock promotion LWM	**page lock promotion LWM**	page lock promotion LWM, page 17-134
lock promotion PCT	**page lock promotion PCT**	page lock promotion PCT, page 17-135

Replaced Configuration Parameter

The new **lock spinlock ratio** parameter replaces the following configuration parameters:

- **page lock spinlock ratio**

Backup and Recovery

The following parameters configure Adaptive Server for backing up and recovering data:

number of large i/o buffers

Summary Information	
Name in pre-11.0 version	N/A
Default value	6
Valid values	1–32
Status	Static
Display level	Comprehensive
Required role	System Administrator

The **number of large i/o buffers** parameter sets the number of 16K buffers reserved for performing large I/O for certain Adaptive Server utilities. These large I/O buffers are used primarily by the **load database** command. Each **load database** command uses one buffer, regardless of the number of stripes specified in the **load database** command. These buffers are not used by **load transaction**. If you need to perform more than six **load database** commands concurrently, configure one large I/O buffer for each **load database** command.

create database and **alter database** use these buffers for large I/O while clearing database pages. Each instance of **create database** or **load database** can use up to eight large I/O buffers.

These buffers are also used by disk mirroring and by some **dbcc** commands.

print recovery information

Summary Information	
Name in pre-11.0 release	**recovery flags**
Default value	0 (off)
Valid values	0 (off), 1 (on)
Status	Static
Display level	Intermediate
Required role	System Administrator

The **print recovery information** parameter determines what information Adaptive Server displays on the console during recovery. (Recovery is done on each database at Adaptive Server start-up and when a database dump is loaded.) The default value is 0, which means that Adaptive Server displays only the database name and a message saying that recovery is in progress. The other value is 1, which means that Adaptive Server displays information about each individual transaction processed during recovery, including whether it was aborted or committed.

recovery interval in minutes

Summary Information	
Name in pre-11.0 release	**recovery interval**
Default value	5
Range of values	1–32767
Status	Dynamic
Display level	Basic
Required role	System Administrator

The **recovery interval in minutes** parameter sets the maximum number of minutes per database that Adaptive Server uses to complete its recovery procedures in case of a system failure. The recovery procedure rolls transactions backward or forward, starting from the transaction that the checkpoint process indicates as the oldest active

transaction. The recovery process has more or less work to do depending on the value of **recovery interval in minutes**.

Adaptive Server estimates that 6000 rows in the transaction log require 1 minute of recovery time. However, different types of log records can take more or less time to recover. If you set **recovery interval in minutes** to 3, the checkpoint process writes changed pages to disk only when *syslogs* contains more than 18,000 rows since the last checkpoint.

➤ ***Note***

The recovery interval has no effect on long-running, minimally logged transactions (such as **create index**) that are active at the time Adaptive Server fails. It may take as much time to reverse these transactions as it took to run them. To avoid lengthy delays, dump each database after index maintenance operations.

Adaptive Server uses the **recovery interval in minutes** setting and the amount of activity on each database to decide when to checkpoint each database. When Adaptive Server checkpoints a database, it writes all **dirty pages** (data pages in cache that have been modified) to disk. This may create a brief period of high I/O, called a **checkpoint spike**.The checkpoint also performs a few other maintenance tasks, including truncating the transaction log for each database for which the **truncate log on chkpt** option has been set. About once per minute, the sleeping checkpoint process "wakes up," checks the **truncate log on chkpt** setting, and checks the recovery interval to determine if a checkpoint is needed. Figure 17-1 shows the logic used by Adaptive Server during this process.

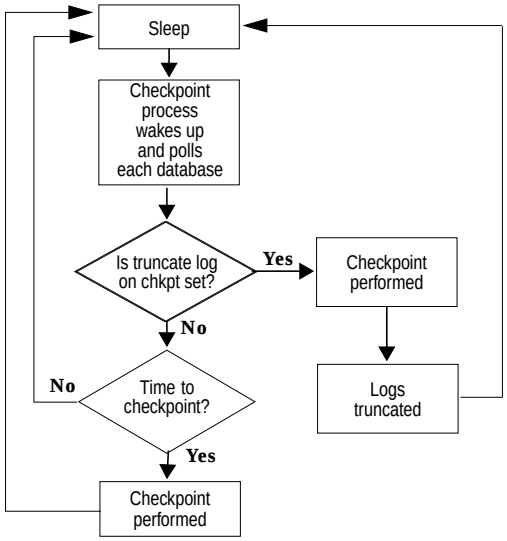


Figure 17-1: The checkpoint process

You may want to change the recovery interval if your application and its use change. For example, you may want to shorten the recovery interval when there is an increase in update activity on Adaptive Server. Shortening the recovery interval causes more frequent checkpoints, with smaller, more frequent checkpoint spikes, and slows the system slightly. On the other hand, setting the recovery interval too high might cause the recovery time to be unacceptably long. The spikes caused by checkpointing can be reduced by reconfiguring the **housekeeper free write percent** parameter. See "housekeeper free write percent" on page 17-126 for further information. For more information on the performance implications of **recovery interval in minutes**, see "Speed of Recovery" on page 32-31 in the *Performance and Tuning Guide*.

Use **sp_sysmon** to determine how a particular recovery interval affects the system. See the *Performance and Tuning Guide* for more information.

tape retention in days

Summary Information	
Name in pre-11.0 release	**tape retention**
Default value	0
Range of values	0–365
Status	Static
Display level	Intermediate
Required role	System Administrator

The **tape retention in days** parameter specifies the number of days you intend to retain each tape after it has been used for either a database or a transaction log dump. It is intended to keep you from accidentally overwriting a dump tape.

For example, if you have set **tape retention in days** to 7 days, and you try to use the tape before 7 days have elapsed since the last time you dumped to that tape, Backup Server issues a warning message.

You can override the warning by using the **with init** option when executing the dump command. Doing this will cause the tape to be overwritten and all data on the tape to be lost.

Both the **dump database** and **dump transaction** commands provide a **retaindays** option, which overrides the **tape retention in days** value for a particular dump. See “Protecting Dump Files from Being Overwritten” on page 27-27 for more information.

Cache Manager

The parameters in this group configure the data and procedure caches.

global async prefetch limit

Summary Information	
Default value	10
Range of values	0–100
Status	Dynamic
Display level	Intermediate
Required role	System Administrator

The **global async prefetch limit** parameter specifies the percentage of a buffer pool that can hold the pages brought in by asynchronous prefetch that have not yet been read. This parameter sets the limit for all pools in all caches for which the limit has not been set explicitly with **sp_poolconfig**.

If the limit for a pool is exceeded, asynchronous prefetch is temporarily disabled until the percentage of unread pages falls below the limit. For more information, see Chapter 34, "Tuning Asynchronous Prefetch," in the *Performance and Tuning Guide*.

global cache partition number

Summary Information	
Default value	1
Range of values	1-64, as powers of 2
Status	Static
Display level	Intermediate
Required role	System Administrator

global cache partition number sets the default number of cache partitions for all data caches. The number of partitions for a particular cache can be set with **sp_cacheconfig**; the local value takes precedence over the global value.

Use cache partitioning to reduce cache spinlock contention; in general, if spinlock contention exceeds 10%, partitioning the cache should improve performance. Doubling the number of partitions cuts spinlock contention by about one-half.

See “Adding Cache Partitions” on page 15-29 for information on configuring cache partitions. See “Reducing Spinlock Contention with Cache Partitions” on page 32-18 in the *Performance and Tuning Guide* for information.

memory alignment boundary

Summary Information	
Name in pre-11.0 release	**calignment**
Default value	2048
Range of values	2048–16384
Status	Static
Display level	Comprehensive
Required role	System Administrator

The **memory alignment boundary** parameter determines the memory address boundary on which data caches are aligned.

Some machines perform I/O more efficiently when structures are aligned on a particular memory address boundary. To preserve this alignment, values for **memory alignment boundary** should always be multiples of 2K.

➤ ***Note***

The **memory alignment boundary** parameter is included for support of certain hardware platforms. Do not modify it unless you are instructed to do so by Sybase Technical Support.

number of index trips

Summary Information	
Name in pre-11.0 release	**cindextrips**
Default value	0
Range of values	0–65535
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

The **number of index trips** parameter specifies the number of times an aged index page traverses the most recently used / least recently used (MRU / LRU) chain before it is considered for swapping out. As you increase the value of **number of index trips**, index pages stay in cache for longer periods of time.

A data cache is implemented as an MRU / LRU chain. As the user threads access data and index pages, these pages are placed on the MRU end of the cache's MRU / LRU chain. In some high transaction environments (and in some benchmarks), it is desirable to keep index pages in cache, since they will probably be needed again soon. Setting **number of index trips** higher keeps index pages in cache longer; setting it lower allows index pages to be swapped out of cache sooner.

You do not need to set the number of index pages parameter for relaxed LRU pages. For more information, see Chapter 15, "Configuring Data Caches."

➤ ***Note***

If the cache used by an index is relatively small (especially if it shares space with other objects) and you have a high transaction volume, do not set **number of index trips** too high. The cache can flood with pages that do not age out, and this may lead to the timing out of processes that are waiting for cache space.

number of oam trips

Summary Information	
Name in pre-11.0 release	**coamtrips**
Default value	0
Range of values	0–65535
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

The **number of oam trips** parameter specifies the number of times an **object allocation map** (**OAM**) page traverses the MRU/LRU chain before it is considered for swapping out. The higher the value of **number of oam trips**, the longer aged OAM pages stay in cache.

Each table, and each index on a table, has an OAM page. The OAM page holds information on pages allocated to the table or index and is checked when a new page is needed for the index or table. (See "page utilization percent" on page 17-42 for further information.) A single OAM page can hold allocation mapping for between 2,000 and 63,750 data or index pages.

The OAM pages point to the allocation page for each allocation unit where the object uses space. The allocation pages, in turn, track the information about extent and page usage within the allocation unit.

In some environments and benchmarks that involve significant allocations of space (that is, massive bulk copy operations), keeping OAM pages in cache longer improves performance. Setting **number of oam trips** higher keeps OAM pages in cache.

➤ ***Note***

If the cache is relatively small and used by a large number of objects, do not set **number of oam trips** too high. This may result in the cache being flooded with OAM pages that do not age out, and user threads may begin to time out.

procedure cache percent

Summary Information	
Name in pre-11.0 release	**procedure cache**
Default value	20
Range of values	1–99
Status	Static
Display level	Comprehensive
Required role	System Administrator

The **procedure cache percent** parameter specifies the percentage of memory allocated to the procedure cache after Adaptive Server's memory needs are met. Adaptive Server's memory needs are the sum of memory necessary for locks, user connections, the code itself, which varies slightly from release to release, and other resources. The remaining memory is divided between the procedure cache and the data cache, according to the value to which **procedure cache percent** has been set.

Adaptive Server uses the procedure cache while running stored procedures. If the server finds a copy of a procedure already in the cache, it does not need to read it from the disk. Adaptive Server also uses space in the procedure cache to compile queries while creating stored procedures.

Since the optimum value for **procedure cache percent** is different from application to application, resetting it may improve Adaptive Server's performance. For example, if you run many different procedures or ad hoc queries, your application will use the procedure cache more heavily, so you may want to increase this value.

Many applications are tested during development with various procedures and ad hoc queries. You may want to try setting this parameter to 50 during your development cycle and resetting it to 20 when your application becomes stable. For further information on configuring procedure caches, see "The Procedure Cache" on page 32-4 of the *Performance and Tuning Guide*.

total data cache size

Summary Information	
Name in pre-11.0 release	N / A
Default value	0
Range of values	0 – 2147483647
Status	Calculated
Display level	Basic
Required role	System Administrator

The **total data cache size** parameter reports the amount of memory, in kilobytes, that is currently available for data, index, and log pages. It is a calculated value that is not directly user-configurable.

The amount of memory available for the data cache can be affected by a number of factors, including:

- The amount of physical memory available on your machine
- The values to which the following parameters are set:
  - **total memory**
  - **number of user connections**
  - **total procedure cache percent**
  - **number of open databases**
  - **number of open objects**
  - **number of open indexes**
  - **number of devices**

A number of other parameters also affect the amount of available memory, but to a lesser extent.

For information on how Adaptive Server allocates memory and for information on data caches, see “Details on Configuration Parameters” on page 17-22.

Component Integration Services Administration

The following parameters configure Adaptive Server for Component Integration Services.

cis bulk insert batch size

Summary Information	
Name in pre-11.0 release	N / A
Default value	0
Range of values	0–2147483647
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

The **cis bulk insert batch size** parameter determines how many rows from the source table(s) are to be bulk copied into the target table as a single batch using **select into**.

If the parameter is left at zero (the default), all rows are copied as a single batch. Otherwise, after the count of rows specified by this parameter has been copied to the target table, the server issues a bulk commit to the target server, causing the batch to be committed.

If a normal client-generated bulk copy operation (such as that produced by the **bcp** utility) is received, then the client is expected to control the size of the bulk batch, and the server ignores the value of this configuration parameter.

cis connect timeout

Summary Information	
Name in pre-11.0 release	N / A
Default value	0
Range of values	0–32767
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

The **cis connect timeout** parameter determines the wait time in seconds for a successful Client-Library connection. By default, no timeout is provided.

cis cursor rows

Summary Information	
Name in pre-11.0 release	N / A
Default value	50
Range of values	1–2147483647
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

The **cis cursor rows** parameter specifies the cursor row count for **cursor open** and **cursor fetch** operations. Increasing this value means more rows will be fetched in one operation. This increases speed but requires more memory. The default is 50.

cis packet size

Summary Information	
Name in pre-11.0 release	N / A
Default value	512
Range of values	512–32768
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

The **cis packet size** parameter specifies the size of Tabular Data Stream™ (TDS) packets that are exchanged between the server and a remote server when a connection is initiated.

The default packet size on most systems is 512 bytes, and this may be adequate for most applications. However, larger packet sizes may result in significantly improved query performance, especially when *text* and *image* or bulk data is involved.

If a packet size larger than the default is specified, and the requested server is a System 10 or later Adaptive Server, then the target server

must be configured to allow variable-length packet sizes. Adaptive Server configuration parameters of interest in this case are:

- **additional netmem**
- **maximum network packet size**

cis rpc handling

Summary Information	
Name in pre-11.0 release	N / A
Default value	0 (off)
Valid values	0 (off), 1 (on)
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

The **cis rpc handling** parameter specifies the default method for remote procedural call (RPC) handling. Setting **cis rpc handling** to 0 sets the Adaptive Server site handler as the default RPC handling mechanism. Setting the parameter to 1 forces RPC handling to use Component Integration Services access methods. For more information, see the discussion on **set cis rpc handling** in the *Component Integration Services User's Guide*.

enable cis

Summary Information	
Name in pre-11.0 release	N / A
Default value	1
Valid values	0 (off), 1 (on)
Status	Static
Display level	Comprehensive
Required role	System Administrator

The **enable cis** parameter enables or disables Component Integration Services.

max cis remote connections

Summary Information	
Name in pre-11.0 release	N / A
Default value	0
Range of values	0–2147483647
Status	Static
Display level	Basic
Required role	System Administrator

The **max cis remote connections** parameter specifies the maximum number of concurrent Client-Library connections that can be made to remote servers by Component Integration Services.

By default, Component Integration Services allows up to four connections per user to be made simultaneously to remote servers. If you set the maximum number of users to 25, up to 100 simultaneous Client-Library connections would be allowed by Component Integration Services.

If this number does not meet the needs of your installation, you can override the setting by specifying exactly how many outgoing Client-Library connections you want the server to be able to make at one time.

max cis remote servers

Summary Information	
Name in pre-11.0 release	N/A
Default value	25
Range of values	10–32767
Status	Static
Display level	Comprehensive
Required role	System Administrator

The **max cis remote servers** parameter specifies the number of concurrent servers that can be accessed from within the server using Client-Library connections.

Disk I/O

The parameters in this group configure Adaptive Server's disk I/O.

allow sql server async i/o

Summary Information	
Name in pre-11.0 release	**T1603** (trace flag)
Default value	1
Valid values	0 (off), 1 (on)
Status	Static
Display level	Comprehensive
Required role	System Administrator

The **allow sql server async i/o** parameter enables Adaptive Server to run with asynchronous disk I/O. Use asynchronous disk I/O, you have to enable it on **both** Adaptive Server **and** your operating system. See your operating system documentation for information on enabling asynchronous I/O at the operating system level.

In all circumstances, disk I/O runs faster asynchronously than synchronously. This is because when Adaptive Server issues an

asynchronous I/O, it does not have to wait for a response before issuing further I/Os.

disable disk mirroring

Summary Information	
Name in pre-11.0 version	N/A
Default value	0
Valid values	1, 0
Status	Static
Display level	Comprehensive
Required role	System Administrator

disable disk mirroring enables or disables disk mirroring for Adaptive Server. This is a global variable; Adaptive Server does not perform any disk mirroring after this configuration parameter is set to 1 and Adaptive Server is rebooted. Setting **disable disk mirroring** to 0 enables disk mirroring.

➤ ***Note***

Disk mirroring must be disabled if you configure Adaptive Server for Failover in a high availability system.

disk i/o structures

Summary Information	
Name in pre-11.0 release	**cnblkio**
Default value	256
Range of values	0–2147483647
Status	Static
Display level	Comprehensive
Required role	System Administrator

The **disk i/o structures** parameter specifies the initial number of disk I/O control blocks Adaptive Server allocates at start-up.

User processes require a disk I/O control block before Adaptive Server can initiate an I/O request for the process. The memory for disk I/O control blocks is preallocated when Adaptive Server starts. You should configure **disk i/o structures** to as high a value as your operating system allows, to minimize the chance of running out of disk I/O structures. Refer to your operating system documentation for information on concurrent disk I/Os.

Use **sp_sysmon** to determine whether you need to allocate more disk I/O structures. See the *Performance and Tuning Guide*. You can set the **max asynch i/os per server** configuration parameter to the same value as **disk i/o structures**. See "max async i/os per server" on page 17-99 for more information.

number of devices

Summary Information	
Name in pre-11.0 release	**devices**
Default value	10
Range of values	1–256
Status	Static
Display level	Basic
Required role	System Administrator

The **number of devices** parameter controls the number of database devices Adaptive Server can use. It does not include devices used for database or transaction log dumps.

When you execute **disk init**, you assign the device number (the *vdevno*). Each device number must be unique among the device numbers used by Adaptive Server. The number 0 is reserved for the master device. Legal numbers are 1–256. However, the highest number must be 1 less than the number of database devices you have configured for Adaptive Server. For example, if you configured your server for 10 devices, the legal range of device numbers is 1–9.

To determine which numbers are currently in use, run **sp_helpdevice** and look in the *device_number* column of output.

If you drop a device with **sp_dropdevice**, you cannot reuse its *vdevno* until you restart Adaptive Server.

If you want to lower the **number of devices** value after you have added database devices, you must first check to see what device numbers are already in use by database devices. The following command prints the highest value in use:

```
select max(low/power(2,24))+1
    from master..sysdevices
```

◆ ***WARNING!***

If you set the number of devices value too low in your configuration file, Adaptive Server cannot start. You can find the devices in use by checking the *sysdevices* system table.

page utilization percent

Summary Information	
Name in pre-11.0 release	N/A
Default value	95
Range of values	1–100
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

The **page utilization percent** parameter is used during page allocations to control whether Adaptive Server scans a table's OAM (**object allocation map**) to find unused pages or simply allocates a new extent to the table. (See "number of oam trips" on page 17-31 for more information on the OAM.) The **page utilization percent** parameter is a performance optimization for servers with very large tables; it reduces the time needed to add new space.

If **page utilization percent** is set to 100, Adaptive Server scans through all OAM pages to find unused pages allocated to the object before allocating a new extent. When this parameter is set lower than 100, Adaptive Server compares the **page utilization percent** setting to the ratio of used and unused pages allocated to the table, as follows:

```
100 * used pages/(used pages + unused pages)
```

If the **page utilization percent** setting is lower than the ratio, Adaptive Server allocates a new extent instead of searching for the unused pages.

For example, when inserting data into a 10GB table that has 120 OAM pages and only 1 unused data page:

- A **page utilization percent** of 100 tells Adaptive Server to scan through all 120 OAM pages to locate an unused data page.
- A **page utilization percent** of 95 allows Adaptive Server to allocate a new extent to the object, because 95 is lower than the ratio of used pages to used and unused pages.

A low **page utilization percent** value results in more unused pages. A high **page utilization percent** value slows page allocations in very large tables, as Adaptive Server performs an OAM scan to locate each unused page before allocating a new extent. This increases logical and physical I/O.

If page allocations (especially in the case of large inserts) seem to be slow, you can lower the value of **page utilization percent**, but be sure to reset it after inserting the data. A lower setting affects all tables on the server and results in unused pages in all tables.

Fast bulk copy ignores the **page utilization percent** setting and always allocates new extents until there are no more extents available in the database.

DTM Administration

The following parameters configure distributed transaction management (DTM) facilities:

dtm detach timeout period

Summary Information	
Name in pre-11.0 release	N/A
Default value	0 (minutes)
Valid values	0 to 2147483647 (minutes)
Status	Dynamic
Display level	10
Required role	System Administrator

dtm detach timeout period sets the amount of time, in minutes, that a distributed transaction branch can remain in the detached state. In some X/Open XA environments, a transaction may become detached from its thread of control (usually to become attached to a different thread of control). Adaptive Server permits transactions to remain in a detached state for the length of time specified by **dtm detach timeout period**. After this time has passed, Adaptive Server rolls back the detached transaction.

dtm lock timeout period

Summary Information	
Name in pre-11.0 release	N / A
Default value	300 (seconds)
Valid values	1 to 2147483647 (seconds)
Status	Dynamic
Display level	10
Required role	System Administrator

dtm lock timeout period sets the maximum amount of time, in seconds, that a distributed transaction branch will wait for lock resources to become available. After this time has passed, Adaptive Server considers the transaction to be in a deadlock situation, and rolls back the transaction branch that triggered the deadlock. This ultimately rolls back the entire distributed transaction.

Distributed transactions may potentially deadlock themselves if they propagate a transaction to a remote server, and in turn, the remote server propagates a transaction back to the originating server. This situation is shown in *Figure 17-2: Distributed transaction deadlock*. In Figure 17-2, the work of distributed transaction "dxact1" is propagated to Adaptive Server 2 via "rpc1." Adaptive Server 2 then propagates the transaction back to the coordinating server via "rpc2." "rpc2" and "dxact1" share the same **gtrid** but have different branch qualifiers, so they cannot share the same transaction resources. If "rpc2" is awaiting a lock held by "dxact1", then a deadlock situation exists.

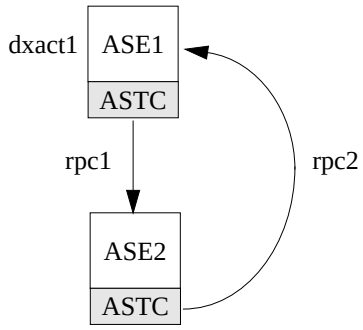


Figure 17-2: Distributed transaction deadlock

Adaptive Server does not attempt to detect inter-server deadlocks. Instead, it relies on **dtm lock timeout period**. In Figure 17-2, after **dtm lock timeout period** has expired, the transaction created for "rpc2" is aborted. This causes Adaptive Server 2 to report a failure in its work, and "dxact1" is ultimately aborted as well.

The value of **dtm lock timeout period** applies only to distributed transactions. Local transactions may use a lock timeout period with the server-wide **lock wait period** parameter.

➤ ***Note***

Adaptive Server does not use **dtm lock timeout period** to detect deadlocks on system tables.

enable DTM

Summary Information	
Name in pre-11.0 release	N/A
Default value	0 (off)
Valid values	0 (off), 1(on)
Status	Static
Display level	10
Required role	System Administrator

enable DTM enables or disables the Adaptive Server Distributed Transaction Management (DTM) feature. When the DTM feature is enabled, you can use Adaptive Server as a resource manager in X/Open XA and MSDTC systems. You must reboot the server for this parameter to take effect. See the *XA Interface Integration Guide for CICS, Encina, and TUXEDO* for more information about using Adaptive Server in an X/Open XA environment. See *Using Adaptive Server Distributed Transaction Management Features* for information about transactions in MSDTC environments, and for information aobut Adaptive Server native transaction coordination services.

➤ ***Note***

You must purchase and install a valid license for the DTM feature before you can set this parameter to 1 (on). If you have not installed a valid license, Adaptive Server logs an error message and does not activate the feature. See your Installation Guide for information about installing license keys.

enable xact coordination

Summary Information	
Name in pre-11.0 release	N / A
Default value	1 (on)
Valid values	0 (off), 1(on)
Status	Static
Display level	10
Required role	System Administrator

enable xact coordination enables or disables Adaptive Server transaction coordination services. When this parameter is set to 1 (on), coordination services are enabled, and the server can propagate transactions to other Adaptive Servers. This may occur when a transaction executes a remote procedure call (RPC) to update data in another server, or updates data in another server using Component Integration Services (CIS). Transaction coordination services ensure that updates to remote Adaptive Server data commit or roll back with the original transaction.

If this parameter is set to 0 (off), Adaptive Server will not coordinate the work of remote servers. Transactions can still execute RPCs and update data using CIS, but Adaptive Server cannot ensure that remote transactions are rolled back with the original transaction or that remote work is committed along with an original transaction, if remote servers experience a system failure. This corresponds to the behavior of Adaptive Server versions prior to version 12.x.

number of dtx participants

Summary Information	
Name in pre-11.0 release	N / A
Default value	500
Valid values	100 to 2147483647
Status	Static
Display level	10
Required role	System Administrator

number of dtx participants sets the total number of remote transactions that the Adaptive Server transaction coordination service can propagate and coordinate at one time. A DTX participant is an internal memory structure that the coordination service uses to manage a remote transaction branch. As transactions are propagated to remote servers, the coordination service must obtain new DTX participants to manage those branches.

By default, Adaptive Server can coordinate 500 remote transactions. Setting **number of dtx participants** to a smaller number reduces the number of remote transactions that the server can manage. If no DTX participants are available, new distributed transactions will be unable to start. In-progress distributed transactions may abort if no DTX participants are available to propagate a new remote transaction.

Setting **number of dtx participants** to a larger number increases the number of remote transaction branches that Adaptive Server can handle, but also consumes more memory.

Optimizing the number of dtx participants for Your System

During a peak period, use **sp_monitorconfig** to examine the use of DTX participants:

```
sp_monitorconfig "number of dtx participants"
Usage information at date and time: Jun 18 1999 9:00AM.

Name            # Free   # Active   % Active  # Max Ever Used   Re-used
--------------  --------  ------   --------  ---------------   -------
number of dtx    480       20       4.00        210               NA
participants
```

If the *#Free* value is zero or very low, new distributed transactions may be unable to start due to a lack of DTX participants. Consider increasing the **number of dtx participants** value.

If the *#Max Ever Used* value is too low, unused DTX participants may be consuming memory that could be used by other server functions. Consider reducing the value of **number of dtx participants**.

strict dtm enforcement

Summary Information	
Name in pre-11.0 release	N / A
Default value	0 (off)
Valid values	0 (off), 1(on)
Status	Static
Display level	10
Required role	System Administrator

strict dtm enforcement determines whether or not Adaptive Server transaction coordination services will strictly enforce the ACID properties of distributed transactions.

In environments where Adaptive Server should propagate and coordinate transactions only to other Adaptive Servers that support transaction coordination, set **strict dtm enforcement** to 1 (on). This ensures that transactions are propagated only to servers that can participate in Adaptive Server-coordinated transactions, and transactions complete in a consistent manner. If a transaction attempts to update data in a server that does not support transaction coordination services, Adaptive Server aborts the transaction.

In heterogeneous environments, you may want to make use of servers that do not support transaction coordination. This includes older versions of Adaptive Server and non-Sybase database stores configured using CIS. Under these circumstances, you can set **strict dtm enforcement** to 0 (off). This allows Adaptive Server to propagate transactions to legacy Adaptive Servers and other data stores, but does not ensure that the remote work of these servers is rolled back or committed with the original transaction.

txn to pss ratio

Summary Information	
Name in pre-11.0 release	N / A
Default value	16
Valid values	1 to 2147483647
Status	Static
Display level	1
Required role	System Administrator

In Adaptive Server version 12.x, transactions are managed as configurable server resources. Each time a new transaction begins, Adaptive Server must obtain a free **transaction descriptor** from a global pool that is created at boot time. Transaction descriptors are internal memory structures that Adaptive Server uses to represent active transactions.

Adaptive Server requires one free transaction descriptor for:

- The outer block of each server transaction. The outer block of a transaction may be created explicitly when a client executes a new **begin transaction** command. Adaptive Server may also implicitly create an outer transaction block when clients use Transact-SQL to modify data without using **begin transaction** to define the transaction.

➤ *Note*

Subsequent, nested transaction blocks, created with additional **begin transaction** commands, do not require additional transaction descriptors.

- Each database accessed in a **multi-database transaction**. Adaptive Server must obtain a new transaction descriptor each time a transaction uses or modifies data in a new database.

txn to pss ratio determines the total number of transaction descriptors available to the server. At boot time, this ratio is multiplied by the **number of user connections** parameter to create the transaction descriptor pool:

```
# of transaction descriptors = number of user connections * txn to pss ratio
```

The default value, 16, ensures compatibility with earlier versions of Adaptive Server. Prior to version 12.x, Adaptive Server allocated 16 transaction descriptors for each user connection. In version 12.x, the number of simultaneous transactions is limited only by the number of transaction descriptors available in the server.

➤ ***Note***

The number of databases accessed in a multi-database transaction remains limited to 16.

Optimizing the txn to pss ratio for Your System

During a peak period, use **sp_monitorconfig** to examine the use of transaction descriptors:

```
sp_monitorconfig "txn to pss ratio"
```

```
Usage information at date and time: Jun 18 1999 8:54AM.

Name            # Free   # Active   % Active  # Max Ever Used   Re-used
--------------  --------  ------   --------   ---------------   -------
txn to pss       784       80       10.20       523               NA
ratio
```

If the *#Free* value is zero or very low, transactions may be delayed as Adaptive Server waits for transaction descriptors to become free in the server. In this case, you should consider increasing the value of **txn to pss ratio**.

If the *#Max Ever Used* value is too low, unused transaction descriptors may be consuming memory that can be used by other server functions. Consider reducing the value of **txn to pss ratio**.

xact coordination interval

Summary Information	
Name in pre-11.0 release	N / A
Default value	60 (seconds)
Valid values	1 to 2147483647 (seconds)
Status	Dynamic
Display level	10
Required role	System Administrator

xact coordination interval defines the length of time between attempts to resolve transaction branches that were propagated to remote servers.

The coordinating Adaptive Server makes regular attempts to resolve the work of remote servers participating in a distributed transaction. The coordinating server contacts each remote server participating in the distributed transaction in a serial manner, as shown in Figure 17-3. The coordination service may be unable to resolve a transaction branch for a variety of reasons. For example, if the remote server is not reachable due to network problems, the coordinating server reattempts the connection after the time specified by **xact coordination level**.

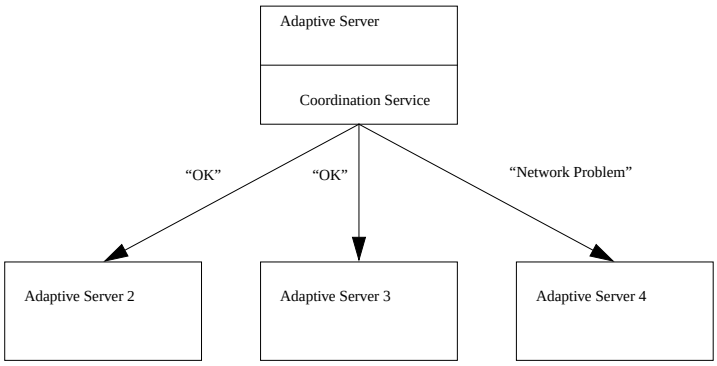


Figure 17-3: Resolving remote transaction branches

With the default value of **xact coordination interval**, 60, Adaptive Server attempts to resolve remote transactions once every minute.

Decreasing the value may speed the completion of distributed transactions, but only if the transactions are themselves resolved in less than a minute. Under normal circumstances, there is no performance penalty to decreasing the value of **xact coordination interval**.

Setting **xact coordination interval** to a higher number can slow the completion of distributed transactions, and cause transaction branches to hold resources longer than they normally would. Under normal circumstances, you should not increase the value of **xact coordination interval** beyond its default.

Error Log

The parameters in this group configure the Adaptive Server error log and the logging of Adaptive Server events to the Windows NT Event Log.

event log computer name (Windows NT Only)

Summary Information	
Name in pre-11.0 release	N / A
Default value	'LocalSystem'
Valid values	• Name of an NT machine on the network configured to record Adaptive Server messages • 'LocalSystem' • 'NULL'
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

The **event log computer name** parameter specifies the name of the Windows NT PC that logs Adaptive Server messages in its Windows NT Event Log. You can use this parameter to have Adaptive Server messages logged to a remote machine. This feature is available on Windows NT servers only.

A value of 'LocalSystem' or 'NULL' specifies the default local system.

You can also use the Server Config utility to set the **event log computer name** parameter by specifying the Event Log Computer Name under Event Logging.

Setting the **event log computer name** parameter with **sp_configure** or specifying the Event Log Computer Name under Event Logging overwrites the effects of the command line **-G** option, if it was specified. If Adaptive Server was started with the **-G** option, you can change the destination remote machine by setting the **event log computer name** parameter.

For more information about logging Adaptive Server messages to a remote site, see *Configuring Adaptive Server for Windows NT*.

event logging (Windows NT Only)

Summary Information	
Name in pre-11.0 release	N / A
Default value	1
Valid values	0 (off), 1 (on)
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

The **event logging** parameter enables and disables the logging of Adaptive Server messages in the Windows NT Event Log. This feature is available on Windows NT servers only.

The default value of 1 enables Adaptive Server message logging in the Windows NT Event Log; a value of 0 disables it.

You use the Server Config utility to set the **event logging** parameter by selecting "Use Windows NT Event Logging" under Event Logging.

Setting the **event logging** parameter or selecting "Use Windows NT Event Logging" overwrites the effects of the command line **-g** option, if it was specified.

log audit logon failure

Summary Information	
Name in pre-11.0 release	N / A
Default value	0 (off)
Range of values	0 (off), 1 (on)
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

The **log audit logon failure** parameter specifies whether to log unsuccessful Adaptive Server logins to the Adaptive Server error log and, on Windows NT servers, to the Windows NT Event Log, if event logging is enabled.

A value of 1 requests logging of unsuccessful logins; a value of 0 specifies no logging.

log audit logon success

Summary Information	
Name in pre-11.0 release	N / A
Default value	0 (off)
Range of values	0 (off), 1 (on)
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

The **log audit logon success** parameter specifies whether to log successful Adaptive Server logins to the Adaptive Server error log and, on Windows NT servers, to the Windows NT Event Log, if event logging is enabled.

A value of 1 requests logging of successful logins; a value of 0 specifies no logging.

Extended Stored Procedures

The parameters in this group affect the behavior of extended stored procedures (ESPs).

esp execution priority

Summary Information	
Name in pre-11.0 release	N / A
Default value	8
Range of values	0–15
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

The **esp execution priority** parameter sets the priority of the XP Server thread for ESP execution. ESPs can be CPU-intensive over long periods of time. Also, since XP Server resides on the same machine as Adaptive Server, XP Server can impact Adaptive Server's performance.

Use **esp execution priority** to set the priority of the XP Server thread for ESP execution. See the *Open Server Server-Library/C Reference Manual* for information about scheduling Open Server threads.

esp execution stacksize

Summary Information	
Name in pre-11.0 release	N / A
Default value	34816
Range of values	34816–2^{14}
Status	Static
Display level	Comprehensive
Required role	System Administrator

The **esp execution stacksize** parameter sets the size of the stack, in bytes, to be allocated for ESP execution.

Use this parameter if you have your own ESP functions that require a larger stack size than the default, 34816.

esp unload dll

Summary Information	
Name in pre-11.0 release	N / A
Default value	0 (off)
Range of values	0 (off), 1 (on)
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

The **esp unload dll** parameter specifies whether DLLs that support ESPs should be automatically unloaded from XP Server memory after the ESP call has completed.

If **esp unload dll** is set to 0, DLLs are not automatically unloaded. If it is set to 1, they are automatically unloaded.

If **esp unload dll** is set to 0, you can still unload individual DLLs explicitly at runtime, using **sp_freedll**.

start mail session (Windows NT Only)

Summary Information	
Name in pre-11.0 release	N / A
Default value	0 (off)
Valid values	0 (off), 1 (on)
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

The **start mail session** parameter enables and disables the automatic initiation of an Adaptive Server mail session when you start Adaptive Server. This feature is available on Windows NT servers only.

A value of 1 configures Adaptive Server to start a mail session the next time Adaptive Server is started. A value of 0 configures Adaptive Server not to start a mail session at the next restart.

If **start mail session** is 0, you can start an Adaptive Server mail session explicitly, using the **xp_startmail** system ESP.

Before setting the **start mail session** parameter, you must prepare your Windows NT system by creating a mailbox and mail profile for Adaptive Server. Then, you must create an Adaptive Server account for Sybmail. See *Configuring Adaptive Server for Windows NT* for information about preparing your system for Sybmail.

xp_cmdshell context

Summary Information	
Name in pre-11.0 release	N / A
Default value	1
Valid values	0, 1
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

The **xp_cmdshell context** parameter sets the security context for the operating system command to be executed using the **xp_cmdshell** system ESP.

Setting **xp_cmdshell context** to 1 restricts the **xp_cmdshell** security context to users who have accounts at the operating system level. Its behavior is platform-specific. If **xp_cmdshell context** is set to 1, to use an **xp_cmdshell** ESP, an operating system user account must exist for the Adaptive Server user name. For example, an Adaptive Server user named “sa” will not be able to use **xp_cmdshell** unless he or she has an operating system level user account named “sa”.

On Windows NT, when **xp_cmdshell context** is set to 1, **xp_cmdshell** succeeds only if the user name of the user logging in to Adaptive Server is a valid Windows NT user name with Windows NT system administration privileges on the system on which Adaptive Server is running.

On other platforms, when **xp_cmdshell context** is set to 1, **xp_cmdshell** succeeds only if Adaptive Server was started by a user with “superuser” privileges at the operating system level. When Adaptive Server gets a request to execute **xp_cmdshell**, it checks the *uid* of the user name of the ESP requestor and runs the operating system command with the permissions of that *uid*.

If **xp_cmdshell context** is 0, the permissions of the operating system account under which Adaptive Server is running are the permissions used to execute an operating system command from **xp_cmdshell**. This allows users to execute operating commands that they would not ordinarily be able to execute under the security context of their own operating system accounts.

General Information

The parameter in this group is not related to any particular area of Adaptive Server behavior.

configuration file

Summary Information	
Name in pre-11.0 release	N / A
Default value	0
Range of values	N / A
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

The **configuration file** parameter specifies the location of the configuration file currently in use. See “Using sp_configure with a Configuration File” on page 17-11 for a complete description of configuration files.

In **sp_configure** output, the “Run Value” column displays only 10 characters. For this reason, the output may not display the entire path and name of your configuration file.

Java Services

The parameters in this group enable and configure memory for Java in Adaptive Server. Refer to *Java in Adaptive Server Enterprise* for complete information about Java in the database.

If you use method calls to JDBC, you may need to increase the size of the execution stack available to the user. See “stack size” on page 17-170 for information about setting the **stack size** parameter.

enable java

Summary Information	
Name in pre-11.0 release	N / A
Default value	0 (disabled)
Range of values	0 (disabled), 1 (enabled)
Status	Static
Display level	Comprehensive
Required role	System Administrator

The **enable java** parameter enables and disables Java in the Adaptive Server database. You cannot install Java classes or perform any Java operations until the server is enabled for Java.

If you change the size of the shared class heap, you must also change the total memory by the same amount.

size of global fixed heap

Summary Information	
Name in pre-11.0 release	N / A
Default value	150 pages (32-bit version) 300 pages (64-bit version)
Range of values	1– 2147483647
Status	Static
Display level	Comprehensive
Required role	System Administrator

The **size of global fixed heap** parameter specifies the memory space for internal data structures and other needs. This parameter is allocated in increments of 2K.

If you change the size of the global fixed heap, you must also change the total memory by the same amount.

size of process object fixed heap

Summary Information	
Name in pre-11.0 release	N / A
Default value	150 pages (32-bit version) 300 pages (64-bit version)
Range of values	1– 2147483647
Status	Static
Display level	Basic
Required role	System Administrator

The **size of process object fixed heap** parameter specifies the memory space for the Java VM for Java objects referenced during the session. This parameter is allocated in 2K increments.

If you change the size of the process object fixed heap, you must multiply the change by the number of user connections and change the total memory by that amount.

size of shared class heap

Summary Information	
Name in pre-11.0 release	N / A
Default value	1536 pages (32-bit version) 3072 pages (64-bit version)
Range of values	1– 2147483647
Status	Static
Display level	Basic
Required role	System Administrator

The **size of shared class heap** parameter specifies the shared memory space for all Java classes called into the Java VM. Adaptive Server maintains the shared class heap server-wide for both user-defined and system-provided Java classes.

If you change the size of the shared class heap, you must change the total memory by the same amount.

Languages

The parameters in this group configure languages, sort orders, and character sets.

default character set id

Summary Information	
Name in pre-11.0 release	**default character set id**
Default value	1
Range of values	0–255
Status	Static
Display level	Intermediate
Required role	System Administrator

The **default character set id** parameter specifies the number of the default character set used by the server. The default is set at installation time, and can be changed later with the Sybase installation utilities. See Chapter 19, "Configuring Character Sets, Sort Orders, and Languages," for a discussion of how to change character sets and sort orders.

default language id

Summary Information	
Name in pre-11.0 release	**default language**
Default value	0
Range of values	0–32767
Status	Dynamic
Display level	Intermediate
Required role	System Administrator

The **default language id** parameter is the number of the language that is used to display system messages unless a user has chosen another language from those available on the server. us_english always has

an ID of NULL. Additional languages are assigned unique numbers as they are added.

default sortorder id

Summary Information	
Name in pre-11.0 release	**default sortorder id**
Default value	50
Range of values	0–255
Status	Static
Display level	Comprehensive
Required role	System Administrator

The **default sortorder id** parameter is the number of the sort order that is installed as the default on the server. To change the default sort order, see Chapter 19, "Configuring Character Sets, Sort Orders, and Languages."

disable character set conversions

Summary Information	
Name in pre-11.0 release	N / A
Default value	0 (enabled)
Valid values	0 (enabled), 1 (disabled)
Status	Static
Display level	Comprehensive
Required role	System Administrator

Changing **disable character set conversions** to 1 turns off character set conversion for data moving between clients and Adaptive Server. By default, Adaptive Server performs conversion on data moving to and from clients that use character sets that are different than the server's. For example, if some clients use Latin-1 (iso_1) and Adaptive Server uses Roman-8 (roman8) as its default character set, data from the clients is converted to Roman-8 when being loaded into Adaptive Server. For clients using Latin-1, the data is

reconverted when it is sent to the client; for clients using the same character set as Adaptive Server, the data is not converted.

By setting **disable character set conversions**, you can request that no conversion take place. For example, if all clients are using a given character set, and you want Adaptive Server to store all data in that character set, you can set **disable character set conversions** to 1, and no conversion will take place.

enable unicode conversion

Summary Information	
Name in pre-11.0 release	N / A
Default value	0
Range of values	0 – 2
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

*Activates Unilib character conversion. Set **enable unicode conversion** to 1 to use the built-in conversion. If it can't find a built-in conversion, Adaptive Server uses the Unilib character conversion. Set **enable unicode conversion** to 2 to use the appropriate Unilibe conversion. Set the parameter to 0 to use only the built-in character-set conversion.

number of languages in cache

Summary Information	
Name in pre-11.0 release	**language in cache**
Default value	3
Range of values	3–100
Status	Static
Display level	Intermediate
Required role	System Administrator

The **number of languages in cache** parameter indicates the maximum number of languages that can be held simultaneously in the language cache.

Lock Manager

The parameters in this group configure locks.

lock address spinlock ratio

Summary Information	
Name in pre-11.0 release	N / A
Default value	100
Range of values	1–2147483647
Status	Static
Display level	Comprehensive
Required role	System Administrator

For Adaptive Servers running with multiple engines, the **address lock spinlock ratio** sets the number of rows in the internal address locks hash table that are protected by one spinlock.

Adaptive Server manages the acquiring and releasing of address locks using an internal hash table with 1031 rows (known as hash buckets). This table can use one or more spinlocks to serialize access between processes running on different engines.

Adaptive Server's default value for **address lock spinlock ratio** is 100, which defines 11 spinlocks for the address locks hash table. The first 10 spinlocks protect 100 rows each, and the eleventh spinlock protects the remaining 31 rows. If you specify a value of 1031 or greater for **address lock spinlock ratio**, Adaptive Server uses only 1 spinlock for the entire table.

number of locks

Summary Information	
Name in pre-11.0 release	**locks**
Default value	5000
Range of values	1000–2147483647
Status	Static
Display level	Basic
Required role	System Administrator

The **number of locks** parameter sets the total number of available locks for all users on Adaptive Server.

The total number of locks needed by Adaptive Server depends on the number and nature of the queries that are running. The number of locks required by a query can vary widely, depending on the number of concurrent and parallel processes and the types of actions performed by the transactions. To see how many locks are in use at a particular time, use **sp_lock**.

For serial operation, we suggest that you can start with an arbitrary number of 20 locks for each active, concurrent connection.

Parallel execution requires more locks than serial execution. For example, if you find that queries use an average of five worker processes, try increasing, by one-third, the **number of locks** configured for serial operation.

If the system runs out of locks, Adaptive Server displays a server-level error message. If users report lock errors, it typically indicates that you need to increase **number of locks**; but remember that locks use memory. See "Number of Locks" on page 14-12 for information.

➤ ***Note***

Datarows locking may require that you change the value for **number of locks**. See the *Performance and Tuning Guide*. for more information.

deadlock checking period

Summary Information	
Name in pre-11.0 release	N / A
Default value	500
Range of values	0–2147483
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

deadlock checking period specifies the minimum amount of time (in milliseconds) before Adaptive Server initiates a deadlock check for a process that is waiting on a lock to be released. Deadlock checking is time-consuming overhead for applications that experience no deadlocks or very few, and the overhead grows as the percentage of lock requests that must wait for a lock also increases.

If you set this value to a nonzero value (*n)*, Adaptive Server initiates a deadlock check after a process waits at least *n* milliseconds. For example, you can make a process wait at least 700 milliseconds. for a lock before each deadlock check as follows:

```
sp_configure "deadlock checking period", 700
```

If you set this parameter to 0, Adaptive Server initiates deadlock checking when each process begins to wait for a lock. Any value less than the number of milliseconds in a clock tick is treated as 0. See “sql server clock tick length” on page 17-148 for more information.

Configuring **deadlock checking period** to a higher value produces longer delays before deadlocks are detected. However, since Adaptive Server grants most lock requests before this time elapses, the deadlock checking overhead is avoided for those lock requests. If your applications deadlock infrequently, set **deadlock checking period** to a higher value to avoid the overhead of deadlock checking for most processes. Otherwise, the default value of 500 should suffice.

Use **sp_sysmon** to determine the frequency of deadlocks in your system and the best setting for **deadlock checking period**. See the *Performance and Tuning Guide* for more information.

deadlock retries

Summary Information	
Name in pre-11.0 release	N / A
Default value	5
Range of values	0–2147483647
Status	Dynamic
Display level	Intermediate
Required role	System Administrator

deadlock retries specifies the number of times a transaction can attempt to acquire a lock when deadlocking occurs during an index page split or shrink.

For example, Figure 17-4 illustrates the following scenario:

- Transaction A locks page 1007 and needs to acquire a lock on page 1009 to update the page pointers for a page split.
- Transaction B is also inserting an index row that causes a page split, holds a lock on page 1009, and needs to acquire a lock on page 1007.

In this situation, rather than immediately choosing a process as a deadlock victim, Adaptive Server relinquishes the index locks for one of the transactions. This often allows the other transaction to complete and release its locks.

For the transaction that surrendered its locking attempt, the index is rescanned from the root page, and the page split operation is attempted again, up to the number of times specified by **deadlock retries**.

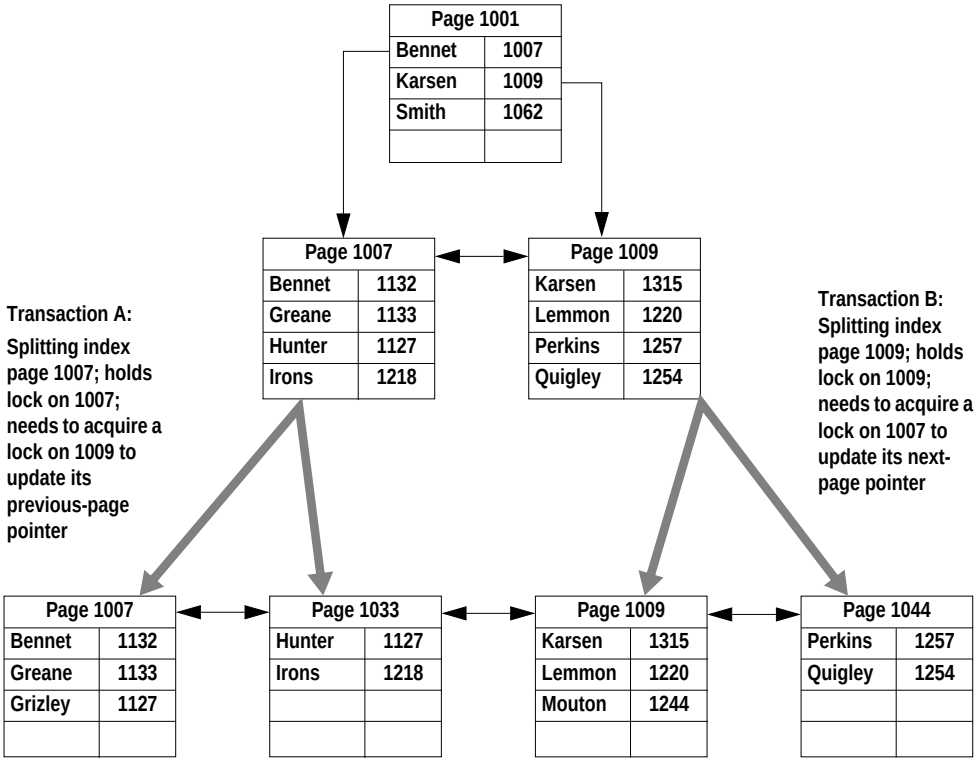


Figure 17-4: Deadlocks during page splitting in a clustered index

sp_sysmon reports on deadlocks and retries. See the *Performance and Tuning Guide* for more information.

freelock transfer block size

Summary Information	
Name in pre-11.0 release	N / A
Default value	30
Range of values	1–2147483647
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

When a process running on a multi-engine Adaptive Server requests a lock, Adaptive Server looks for one in its engine's freelock list. If the engine freelock list is out of locks, Adaptive Server moves a certain number of locks from its global freelock list to the engine freelock list. After a process completes, the locks released by those processes accumulate in the engine's freelock list. When the number of locks in the engine list reaches its maximum (defined by the **max engine freelocks** parameter), Adaptive Server moves a number of locks from the engine freelock list to the global freelock list. This replenishes the number of locks available to other engines from the global list.

freelock transfer block size specifies the number of locks moved between the engine freelock lists and the global freelock list. You can change the transfer size to 50 locks as follows:

```
sp_configure "freelock transfer block size", 50
```

When you set this to a higher value, the frequency of transfers between the engine freelock list and the global freelock list is reduced, which lowers the contention in accessing the global freelock list. However, a higher value can result in accessing many more lock structures than a process needs. The maximum value allowed for **freelock transfer block size** cannot exceed more than half the maximum number of locks available to an engine's freelock list, as defined by the following formula:

((**max engine freelocks** percent value * **number of locks** value) / **max online engines** value) / 2

For example, if **max engine freelocks** is set to 10 percent and the **number of locks** value is 5000, the maximum value allowed for **freelock transfer block size** is 50 for an Adaptive Server running with 5 engines.

If you try to set **freelock transfer block size** to a value that is higher than its maximum value, Adaptive Server returns an error message and leaves the parameter unchanged. It also returns an error if the current **freelock transfer block size** value will exceed the maximum when you attempt to increase **max online engines** or decrease either **max engine freelocks** or **number of locks**. Adaptive Server sets this maximum to avoid draining the engine freelock lists of too many locks, which can force it to get more locks immediately from the global freelock list.

max engine freelocks

Summary Information	
Name in pre-11.0 release	N / A
Default value	10
Range of values	1–50
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

When a process running on a multi-engine Adaptive Server requests a lock, it looks for one in its engine's freelock list. If the engine freelock list is out of locks, Adaptive Server moves a certain number of locks (defined by the **freelock transfer block size** parameter) from its global freelock list to the engine freelock list. The total number of locks in the global freelock list is defined by the **number of locks** parameter value. For a single engine Adaptive Server, the entire global freelock list is moved to the engine freelock list at server start-up, regardless of the value of this parameter.

After an engine completes a process, all the locks held by that process are released and returned to that engine's freelock list. This reduces the contention of each engine accessing the global freelock list. However, if the number of locks released to the engine exceed the maximum number of locks allowed in the engine's freelock list, Adaptive Server moves a number of locks (defined by **freelock transfer block size**) to the global freelock list. This replenishes the number of locks available to other engines from the global list.

You can specify the maximum number of locks available to the engine freelock lists as a percentage of the total number of locks available to your server by using **max engine freelocks**. For example, 20

percent of the total number of locks can be the maximum number of locks available to the engine freelock lists, as follows:

```
sp_configure "max engine freelocks", 20
```

If your server has 5000 locks configured, 20 percent (or 1000) of those locks represents the maximum number of locks available to each engine freelock list. The maximum for each engine freelock list depends on the number of engines configured for Adaptive Server (**max online engines** parameter). If your server has 5 engines, the maximum for each engine freelock list is 1000 divided by 5, or 200 locks. Therefore, a change in **number of locks** or **max online engines** can affect the maximum for each engine freelock list, even if the value for **max engine freelocks** remains the same.

For some servers, if you set **max engine freelocks** too high, most of the available locks may end up in each engine's freelock list, leaving very few locks in Adaptive Server's global freelock list. If an engine's freelock list becomes empty, it is likely that the global freelock list is also empty, which results in Adaptive Server error message 1279, even though other engines have locks in their freelock lists. Error message 1279 reads as follows:

```
SQL Server has run out of locks on engine %d. Re-
run your command when there are fewer active
users, or contact a user with System Administrator
(SA) role to reconfigure max engine freelocks.
```

You should either decrease the value for **max engine freelocks** or increase the value of **number of locks** to avoid frequent occurrences of message 1279. This message differs from message 1204, which indicates that Adaptive Server has no more locks in either the global freelock list or the engine freelock lists.

lock spinlock ratio

Summary Information	
Default value	85
Range of values	1–2147483647
Status	Static
Display level	Comprehensive
Required role	System Administrator

Adaptive Server manages the acquiring and releasing of locks using an internal hash table with a configurable number of hash buckets. On SMP systems, this hash table can use one or more spinlocks to serialize access between processes running on different engines. To set the number of hash buckets, use the **lock hashtable size**.

For Adaptive Servers running with multiple engines, the **lock spinlock ratio** sets a ratio that determines the number of lock hash buckets that are protected by one spinlock. If you increase **lock hashtable size**, the number of spinlocks increases, so the number of hash buckets protected by one spinlock remains the same.

Adaptive Server's default value for **lock spinlock ratio** is 85. With **lock hashtable size** set to the default value of 2048, the default spinlock ratio defines 26 spinlocks for the lock hash table. For more information about configuring spinlock ratios, see "Configuring Spinlock Ratio Parameters," in Chapter 10, "Managing Multiprocessor Servers" in the *System Administration Guide*.

sp_sysmon reports on the average length of the hash chains in the lock hash table. See the *Performance and Tuning Guide* for more information.

lock hashtable size

Summary Information	
Default value	2048
Range of values	1–2147483647
Status	Static
Display level	Comprehensive
Required role	System Administrator

lock hashtable size specifies the number of **hash buckets** in the lock hash table. This table manages all row, page, and table locks and all lock requests. Each time a task acquires a lock, the lock is assigned to a hash bucket, and each lock request for that lock checks the same hash bucket. Setting this value too low results in large numbers of locks in each hash bucket and slows the searches. On Adaptive Servers with multiple engines, setting this value too low can also lead to increased spinlock contention. Do not set the value to less than the default value, 2048.

lock hashtable size must be a power of 2. If the value you specify is not a power of 2, **sp_configure** rounds the value to the next highest power of 2 and prints an informational message.

The optimal hash table size is a function of the number of distinct objects (pages, tables, and rows) that will be locked concurrently. The optimal hash table size is at least 20 percent of the number of distinct objects that need to be locked concurrently. See *Performance and Tuning Guide* for more information on configuring the lock hash table size.

lock scheme

Summary Information	
Default value	allpages
Range of values	allpages, datapages, datarows
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

lock scheme sets the default locking scheme to be used by **create table** and **select into** commands when a lock scheme is not specified in the command.

The values for lock scheme are character data, so you must use 0 as a placeholder for the second parameter, which must be numeric, and specify **allpages**, **datapages**, or **datarows** as the third parameter:

```
sp_configure "lock scheme", 0, datapages
```

lock wait period

Summary Information	
Default value	2147483647
Range of values	0–2147483647
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

lock wait period limits the number of seconds that tasks wait to acquire a lock on a table, data page, or data row. If the task does not acquire the lock within the specified time period, Adaptive Server returns error message 12205 to the user and rolls back the transaction.

The **lock wait** option of the **set** command sets a session-level number of seconds that a task will wait for a lock. It overrides the server-level setting for the session.

At the default value, all processes wait indefinitely for locks. To restore the default value, reset the value to 2147483647 or use:

```
sp_configure "lock wait period", 0, "default"
```

read committed with lock

Summary Information	
Default value	0 (off)
Valid values	0 (off), 1(on)
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

read committed with lock determines whether an Adaptive Server using transaction isolation level 1 (read committed) holds shared locks on rows or pages of data-only-locked tables during **select** queries. For cursors, the option applies only to cursors declared as read-only. By default, this parameter is turned off to reduce lock contention and blocking. This parameter affects only queries on data-only locked tables.

For transaction isolation level 1, **select** queries on allpages-locked tables continue to hold locks on the page at the current position. Any updatable cursor on a data-only-locked table also holds locks on the current page or row. See the *Performance and Tuning Guide* for more information.

lock table spinlock ratio

Summary Information	
Name in pre-11.0 release	N / A
Default value	20
Range of values	1–2147483647
Status	Static
Display level	Comprehensive
Required role	System Administrator

For Adaptive Servers running with multiple engines, the **table lock spinlock ratio** configuration parameter sets the number of rows in the internal table locks hash table that are protected by one **spinlock**.

Adaptive Server manages the acquiring and releasing of table locks using an internal hash table with 101 rows (known as hash buckets). This table can use one or more spinlocks to serialize access between processes running on different engines.

Adaptive Server's default value for **table lock spinlock ratio** is 20, which defines 6 spinlocks for the table locks hash table. The first 5 spinlocks protect 20 rows each; the sixth spinlock protects the last row. If you specify a value of 101 or greater for **table lock spinlock ratio**, Adaptive Server uses only 1 spinlock for the entire table.

size of unilib cache

Summary Information	
Name in pre-11.0 release	N / A
Default value	0
Range of values	0 – 2147483647
Status	Static
Display level	Comprehensive
Required role	System Administrator

Determines the size of the unilib cache. size of unilib specifies the size in bytes. You may need a larger cache if your site uses multiple conversions.

Memory Use

The following parameter optimizes Adaptive Server's memory use:

executable codesize + overhead

Summary Information	
Name in pre-11.0 release	**sql server code size**
Default value	0
Range of values	0-2147483647
Status	Calculated
Display level	Basic
Required role	System Administrator

executable codesize + overhead reports the combined size (in kilobytes) of the Adaptive Server executable and overhead. It is a calculated value and is not user-configurable.

Metadata Caches

The following parameters help set the metadata cache size for frequently used system catalog information. The **metadata cache** is a reserved area of memory used for tracking information on databases, indexes, or objects. The greater the number of open databases, indexes, or objects, the larger the metadata cache size. For a discussion of metadata caches in a memory-usage context, see "Open Databases, Open Indexes, and Open Objects" on page 14-12.

number of open databases

Summary Information	
Name in pre-11.0 release	**open databases**
Default value	12
Range of values	5–2147483647
Status	Static
Display level	Basic
Required role	System Administrator

number of open databases sets the maximum number of databases that can be open simultaneously on Adaptive Server.

When you calculate a value, include the system databases *master*, *model*, *sybsystemprocs*, and *tempdb*. If you have installed auditing, include the *sybsecurity* database. Also, count the sample databases *pubs2* and *pubs3*, the syntax database *sybsyntax*, and the **dbcc** database *dbccdb* if they are installed.

If you are planning to make a substantial change, such as loading a large database from another server, you can calculate an estimated metadata cache size by using **sp_helpconfig**. **sp_helpconfig** displays the amount of memory required for a given number of metadata descriptors, as well as the number of descriptors that can be accommodated by a given amount of memory. A database metadata descriptor represents the state of the database while it is in use or cached between uses.

Optimizing the *number of open databases* Parameter for Your System

If Adaptive Server displays a message saying that you have exceeded the allowable number of open databases, you will need to adjust the value.

To set the **number of open databases** parameter optimally:

- Step 1: Determine the total number of databases (database metadata descriptors).
- Step 2: Reset **number of open databases** to that number.
- Step 3: Restart Adaptive Server.
- Step 4: Find the number of active databases (active metadata descriptors) during a peak period.
- Step 5: Reset **number of open databases** to that number, plus 10 percent.
- Step 6: Restart Adaptive Server.

The following section details the basic steps listed above.

1. Use the **sp_countmetadata** system procedure to find the total number of database metadata descriptors. For example:

   ```
   sp_countmetadata "open databases"
   ```

   The best time to run **sp_countmetadata** is when there is little activity on the server. Running **sp_countmetadata** during a peak time can cause contention with other processes.

   Suppose Adaptive Server reports the following information:

   ```
   There are 50 databases, requiring 1719 Kbytes of
   memory. The 'open databases' configuration
   parameter is currently set to 500.
   ```

2. Configure **number of open databases** with the value of 50:

   ```
   sp_configure "number of open databases", 50
   ```

3. Restart the server.

   This new configuration is only a start; the ideal size should be based on the number of **active** metadata database cache descriptors, not the **total** number of databases.

4. During a peak period, find the number of active metadata descriptors. For example:

   ```
   sp_monitorconfig "open databases"
   Usage information at date and time: Jan 14 1997  8:54AM.
   ```

```
Name            # Free   # Active   % Active  # Max Ever Used   Re-used
--------------  --------  ------   --------   ---------------   -------
number of open  50        20       40.00      26                No
databases
```

At this peak period, 20 metadata database descriptors are active; the maximum number of descriptors that have been active since the server was last started is 26.

See **sp_monitorconfig** in the *Adaptive Server Reference Manual* for more information.

5. Configure **number of open databases** to 26, plus additional space for 10 percent more (about 3), for a total of 29:

   ```
   sp_configure "number of open databases", 29
   ```

6. Restart the server.

If there is a lot of activity on the server, for example, if databases are being added or dropped, run **sp_monitorconfig** periodically. You will need to reset the cache size as the number of active descriptors changes. However, avoid changing **number of open databases** too often, since you will need to restart Adaptive Server each time.

number of open indexes

Summary Information	
Name in pre-11.0 release	N / A
Default value	500
Range of values	100–2147483647
Status	Static
Display level	Basic
Required role	System Administrator

number of open indexes sets the maximum number of indexes that can be used simultaneously on Adaptive Server.

If you are planning to make a substantial change, such as loading databases with a large number of indexes from another server, you can calculate an estimated metadata cache size by using **sp_helpconfig. sp_helpconfig** displays the amount of memory required for a given number of metadata descriptors, as well as the number of descriptors that can be accommodated by a given amount of memory. An index

metadata descriptor represents the state of an index while it is in use or cached between uses.

Optimizing the *number of open indexes* Parameter for Your System

The default run value is 500. If this number is insufficient, Adaptive Server displays a message after trying to reuse active index descriptors, and you will need to adjust this value.

In order to configure the **number of open indexes** parameter optimally, perform the following steps:

1. Use **sp_countmetadata** to find the total number of index metadata descriptors. For example:

   ```
   sp_countmetadata "open indexes"
   ```

   The best time to run **sp_countmetadata** is when there is little activity in the server. Running **sp_countmetadata** during a peak time can cause contention with other processes.

   Suppose Adaptive Server reports the following information:

   ```
   There are 698 user indexes in all database(s),
   requiring 286.289 Kbytes of memory. The 'open
   indexes' configuration parameter is currently set
   to 500.
   ```

2. Configure the **number of open indexes** parameter to 698 as follows:

   ```
   sp_configure "number of open indexes", 698
   ```

3. Restart the server.

   This new configuration is only a start; the ideal size should be based on the number of *active* index metadata cache descriptors, not the total number of indexes.

4. During a peak period, find the number of active index metadata descriptors. For example:

   ```
   sp_monitorconfig "open indexes"
   ```

```
Usage information at date and time: Jan 14 1997 8:54AM.

Name            # Free   # Active   % Active  # Max Ever Used   Re-used
--------------  --------  ------   --------   ---------------   -------
number of open  182       516      73.92      590               No
indexes
```

In this example, 590 is the maximum number of index descriptors that have been used since the server was last started.

See **sp_monitorconfig** in the *Adaptive Server Reference Manual* for more information.

5. Configure the **number of open indexes** configuration parameter to 590, plus additional space for 10 percent more (59), for a total of 649:

   ```
   sp_configure "number of open indexes", 649
   ```

6. Restart the server.

If there is a lot of activity on the server, for example, if tables are being added or dropped, run **sp_monitorconfig** periodically. You will need to reset the cache size as the number of active descriptors changes. However, avoid changing **number of open indexes** too often, since you need to restart Adaptive Server each time.

number of open objects

Summary Information	
Name in pre-11.0 release	**open objects**
Default value	500
Range of values	100–2147483647
Status	Static
Display level	Basic
Required role	System Administrator

number of open objects sets the maximum number of objects that can be open simultaneously on Adaptive Server.

If you are planning to make a substantial change, such as loading databases with a large number of objects from another server, you can calculate an estimated metadata cache size by using **sp_helpconfig**. **sp_helpconfig** displays the amount of memory required for a given number of metadata descriptors, as well as the number of descriptors that can be accommodated by a given amount of memory. An object metadata descriptor represents the state of an object while it is in use, or cached between uses.

Optimizing the *number of open objects* Parameter for Your System

The default run value is 500. If this number is insufficient, Adaptive Server displays a message after trying to re-use active object descriptors. You will need to adjust this value.

To set the **number of open objects** parameter optimally:

1. Use **sp_countmetadata** to find the total number of object metadata cache descriptors. For example:

   ```
   sp_countmetadata "open objects"
   ```

   The best time to run **sp_countmetadata** is when there is little activity in the server. Running **sp_countmetadata** during a peak time can cause contention with other processes.

   Suppose Adaptive Server reports the following information:

   ```
   There are 340 user objects in all database(s),
   requiring 140.781 Kbytes of memory. The 'open
   objects' configuration parameter is currently set
   to 500
   ```

2. Configure the number of open objects parameter to that value, as follows:

   ```
   sp_configure "number of open objects", 357
   ```

   357 covers the 340 user objects, plus 5 percent to accommodate temporary tables.

3. Restart the server.

   This new configuration is only a start; the ideal size should be based on the number of *active* object metadata cache descriptors, not the *total* number of objects.

4. During a peak period, find the number of active metadata cache descriptors, for example:

   ```
   sp_monitorconfig "open objects"
   ```

```
Usage information at date and time: Jan 14 1997 8:54AM.

Name            # Free   # Active   % Active  # Max Ever Used   Re-used
--------------  --------  ------   --------   ---------------   -------
number of open  160       357      71.40      397               No
objects
```

   In this example, 397 is the maximum number of object descriptors that have been used since the server was last started.

5. Configure the **number of open objects** to 397, plus 10 percent (40), for a total of 437:

   ```
   sp_configure "number of open objects", 437
   ```

6. Restart the server.

If there is a lot of activity on the server, for example, if tables are being added or dropped, run **sp_monitorconfig** periodically. You will need to reset the cache size as the number of active descriptors changes. However, avoid changing the **number of open objects** too often, since you

need to restart Adaptive Server before it can take effect. See **sp_monitorconfig** in the *Adaptive Server Reference Manual* for more information.

open index hash spinlock ratio

Summary Information	
Name in pre-11.0 release	N / A
Default value	100
Range of values	1–2147483647
Status	Static
Display level	Basic
Required role	System Administrator

open index hash spinlock ratio sets the number of index metadata descriptor hash tables that are protected by one **spinlock**. This parameter is used for multiprocessing systems only.

All the index descriptors belonging to the table are accessible through a hash table. When a query is run on the table, Adaptive Server uses hash tables to look up the necessary index information in its *sysindexes* rows. A hash table is an internal mechanism used by Adaptive Server to retrieve information quickly.

Usually, you do not need to change this parameter. In rare instances, however, you may need to reset it if Adaptive Server demonstrates contention from hash spinlocks. You can get information about spinlock contention by using **sp_sysmon**. For more about **sp_sysmon**, see the *Performance and Tuning Guide*.

For more information about configuring spinlock ratios, see "Configuring Spinlock Ratio Parameters" on page 16-9.

open index spinlock ratio

Summary Information	
Name in pre-11.0 release	N / A
Default value	100
Range of values	1–214748364
Status	Static
Display level	Comprehensive
Required role	System Administrator

open index spinlock ratio specifies the number of index metadata descriptors that are protected by one **spinlock**.

Adaptive Server uses a spinlock to protect an index descriptor, since more than one process can access the contents of the index descriptor. This parameter is used for multiprocessing systems only.

The value specified for this parameter defines the ratio of index descriptors per spinlock.

If one spinlock is shared by too many index descriptors, it can cause spinlock contention. Use **sp_sysmon** to get a report on spinlock contention. See the *Performance and Tuning Guide* more information. If **sp_sysmon** output indicates an index descriptor spinlock contention of more than 3 percent, try decreasing the value of **open index spinlock ratio**.

For more information about configuring spinlock ratios, see “Configuring Spinlock Ratio Parameters” on page 16-9.

open object spinlock ratio

Summary Information	
Name in pre-11.0 release	N / A
Default value	100
Range of values	1–2147483647
Status	Static
Display level	Comprehensive
Required role	System Administrator

open object spinlock ratio specifies the number of object descriptors that are protected by one **spinlock**. Adaptive Server uses a spinlock to protect an object descriptor, since more than one process can access the contents of the object descriptor. This configuration parameter is used for multiprocessing systems only.

The default value for this parameter is 100; 1 spinlock for each 100 object descriptors configured for your server. If your server is configured with only one engine, Adaptive Server sets only 1 object descriptor spinlock, regardless of the number of object descriptors.

If one spinlock is shared by too many object descriptors, it causes spinlock contention. Use **sp_sysmon** to get a report on spinlock contention. See the *Performance and Tuning Guide* for more information on spinlock contention. If **sp_sysmon** output indicates an object descriptor spinlock contention of more than 3 percent, try decreasing the value of the **open object spinlock ratio** parameter.

For more information about configuring spinlock ratios, see “Configuring Spinlock Ratio Parameters” on page 16-9.

Network Communication

Use the parameters in this group to configure communication between Adaptive Server and remote servers, and between Adaptive Server and client programs.

allow remote access

Summary Information	
Name in pre-11.0 release	**remote access**
Default value	1 (on)
Valid values	0 (off), 1 (on)
Status	Dynamic
Display level	Intermediate
Required role	System Security Officer

allow remote access controls logins from remote Adaptive Servers. The default value of 1 allows Adaptive Server to communicate with Backup Server. Only a System Security Officer can set **allow remote access**.

Setting the value to 0 disables server-to-server RPCs. Since Adaptive Server communicates with Backup Server via RPCs, setting this parameter to 0 makes it impossible to back up a database.

Since other system administration actions are required to enable remote servers other than Backup Server to execute RPCs, leaving this option set to 1 does not constitute a security risk.

allow sendmsg

Summary Information	
Default value	0 (off)
Valid values	0 (off), 1 (on)
Status	Dynamic
Display level	Comprehensive
Required role	System Security Officer

The **allow sendmsg** parameter enables or disables sending messages from Adaptive Server to a UDP (User Datagram Protocol) port. When allow sendmsg is set to 1, any user can send messages using **sp_sendmsg** or **syb_sendmsg**. To set the port number used byAdaptive Server, see “syb_sendmsg port number” on page 17-97.

➤ ***Note***

Sending messages to UDP ports is not supported on Windows NT.

default network packet size

Summary Information	
Name in pre-11.0 release	**default network packet size**
Default value	512
Range of values	512–524288
Status	Static
Display level	Intermediate
Required role	System Administrator

default network packet size configures the default packet size for all Adaptive Server users. You can set **default network packet size** to any multiple of 512 bytes; values that are not even multiples of 512 are rounded down.

Memory for all users who log in with the default packet size is allocated from Adaptive Server's memory pool, as set with **total memory**. This memory is allocated for network packets when Adaptive Server is started.

Each Adaptive Server user connection uses:

- One read buffer
- One buffer for messages
- One write buffer

Each of these buffers requires **default network packet size** bytes. The total amount of memory allocated for network packets is:

(**number of user connections** + **number of worker processes**) * 3 * **default network packet size**

For example, if you set the **default network packet size** to 1024 bytes, and you have 50 user connections and 20 worker processes, the amount of network memory required is:

(50 + 20) * 3 * 1024 = 215040 bytes

If you increase the **default network packet size**, you must also increase the **max network packet size** to at least the same size. If the value of **max network**

packet size is greater than the value of **default network packet size**, to increase the value of **additional network memory**. See "additional network memory" on page 17-107 for further information.

Use **sp_sysmon** to see how changing the **default network packet size** parameter affects network I/O management and task switching. For example, try increasing **default network packet size** and then checking **sp_sysmon** output to see how this affects **bcp** for large batches. See the *Performance and Tuning Guide* for more information.

Requesting a Larger Packet Size at Login

The default packet size for most client programs like **bcp** and **isql** is set to 512 bytes. If you change the default packet size, clients must request the larger packet size when they connect. Use the **-A** flag to Adaptive Server client programs to request a large packet size. For example:

```
isql -A2048
```

max network packet size

Summary Information	
Name in pre-11.0 release	**maximum network packet size**
Default value	512
Range of values	512–524288
Status	Static
Display level	Intermediate
Required role	System Administrator

max network packet size specifies the maximum network packet size that can be requested by clients communicating with Adaptive Server.

If some of your applications send or receive large amounts of data across the network, these applications can achieve significant performance improvement by using larger packet sizes. Two examples are large bulk copy operations and applications that read or write large *text* or *image* values.

Generally, you want:

- The value of **default network packet size** to be small for users who perform short queries

- **max network packet size** to be large enough to allow users who send or receive large volumes of data to request larger packet sizes

max network packet size must always be as large as, or larger than, the **default network packet size**. Values that are not even multiples of 512 are rounded down.

For client applications that explicitly request a larger network packet size to receive it, you must also configure additional network memory. See "additional network memory" on page 17-107 for more information.

See **bcp** and **isql** in the *Utility Programs* manual for your platform manual for information on using larger packet sizes from these programs. Open Client Client-Library documentation includes information on using variable packet sizes.

Choosing Packet Sizes

For best performance, choose a server packet size that works efficiently with the underlying packet size on your network. The goals are:

- Reducing the number of server reads and writes to the network
- Reducing unused space in network packets (increasing network throughput)

For example, if your network packet size carries 1500 bytes of data, setting Adaptive Server's packet size to 1024 (512*2) will probably achieve better performance than setting it to 1536 (512*3).
Figure 17-5 shows how four different packet size configurations would perform in such a scenario.

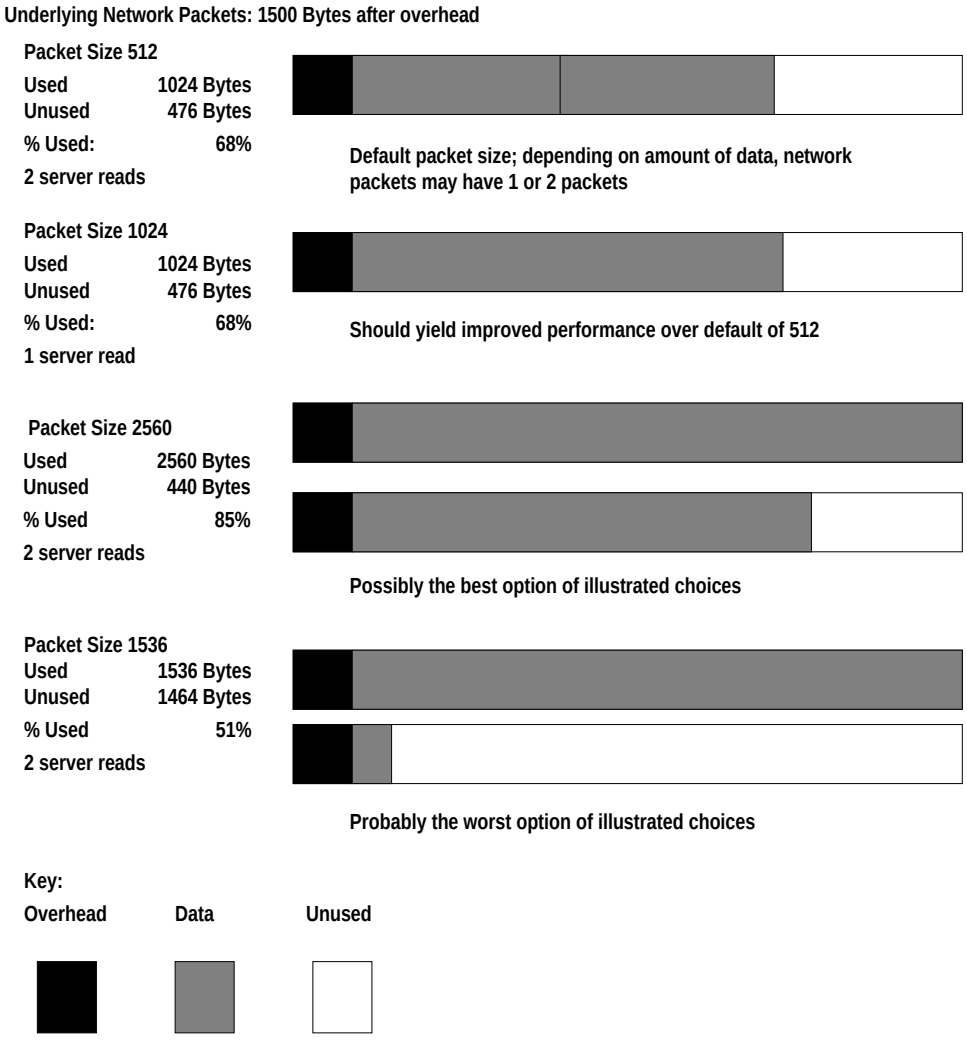


Figure 17-5: Factors in determining packet size

After you determine the available data space of the underlying packets on your network, perform your own benchmark tests to determine the optimum size for your configuration.

Use **sp_sysmon** to see how changing **max network packet size** affects network I/O management and task switching. For example, try increasing **max network packet size** and then checking **sp_sysmon** output

to see how this affects **bcp** for large batches. See the *Performance and Tuning Guide* for more information.

max number network listeners

Summary Information	
Name in pre-11.0 release	**cmaxnetworks**
Default value	5
Range of values	0–2147483647
Status	Static
Display level	Comprehensive
Required role	System Administrator

max number network listeners specifies the maximum number of network listeners allowed by Adaptive Server at one time.

Each master port has one network listener. Generally, there is no need to have multiple master ports, unless your Adaptive Server needs to communicate over more than one network type. Some platforms support both socket and TLI (Transport Layer Interface) network interfaces. Refer to the configuration documentation for your platform for information on supported network types.

number of remote connections

Summary Information	
Name in pre-11.0 release	**remote connections**
Default value	20
Range of values	5–32767
Status	Static
Display level	Intermediate
Required role	System Administrator

number of remote connections specifies the number of logical connections that can be open to and from an Adaptive Server at one time. Each simultaneous connection to XP Server for ESP execution uses up to

one remote connection each. For more information, see Chapter 9, "Managing Remote Servers."

number of remote logins

Summary Information	
Name in pre-11.0 release	**remote logins**
Default value	20
Range of values	0–32767
Status	Static
Display level	Intermediate
Required role	System Administrator

number of remote logins controls the number of active user connections from Adaptive Server to remote servers. Each simultaneous connection to XP Server for ESP execution uses up to one remote login each. You should set this parameter to the same (or a lower) value as **number of remote connections**. For more information, see Chapter 9, "Managing Remote Servers."

number of remote sites

Summary Information	
Name in pre-11.0 release	**remote sites**
Default value	10
Range of values	0–32767
Status	Static
Display level	Intermediate
Required role	System Administrator

number of remote sites determines the maximum number of remote sites that can access Adaptive Server simultaneously. An each Adaptive Server-to-XP Server connection uses one remote site connection.

Internally, **number of remote sites** determines the number of site handlers that can be active at any one time; all server accesses from a

single site are managed with a single site handler. For more information, see Chapter 9, “Managing Remote Servers.”

remote server pre-read packets

Summary Information	
Name in pre-11.0 release	**pre-read packets**
Default value	3
Range of values	3–32767
Status	Static
Display level	Intermediate
Required role	System Administrator

remote server pre-read packets determines the number of packets that will be “pre-read” by a site handler during connections with remote servers.

All communication between two servers is managed through a single site handler, to reduce the required number of connections. The site handler can pre-read and keep track of data packets for each user process before the receiving process is ready to accept them.

The default value for **remote server pre-read packets** is appropriate for most servers. Increasing the value uses more memory; decreasing the value can slow network traffic between servers. For more information, see Chapter 9, “Managing Remote Servers.”

syb_sendmsg port number

Summary Information	
Default value	0
Valid values	0, or 1024 - 65535, or system limit
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

The **syb_sendmsg port number** parameter specifies the port number that Adaptive Server uses to send messages to a UDP (User Datagram Protocol) port with **sp_sendmsg** or **syb_sendmsg**.

If more than one engine is configured, a port is used for each engine, numbered consecutively from the port number specified. If the port number is set to the default value, 0 Adaptive Server assigns port numbers.

➤ ***Note***

Sending messages to UDP ports is not supported on Windows NT.

A System Security Officer must set the **allow sendmsg** configuration parameter to 1 to enable sending messages to UDP ports. To enable UDP messaging, a System Administrator must set allow **allow sendmsg** to 1. See “allow sendmsg” on page 17-89. For more information on UDP messaging, see **sp_sendmsg** in the *Adaptive Server Reference Manual*.

tcp no delay

Summary Information	
Name in pre-11.0 release	**T1610** (trace flag)
Default value	0 (off)
Valid values	0 (off), 1 (on)
Status	Static
Display level	Comprehensive
Required role	System Administrator

The **tcp no delay** parameter controls TCP (Transmission Control Protocol) packet batching. The default value is 0, which means that TCP packets are batched.

TCP normally batches small logical packets into single larger physical packets (by briefly delaying packets) fill physical network frames with as much data as possible. This is intended to improve network throughput in terminal emulation environments where there are mostly keystrokes being sent across the network.

However, applications that use small TDS (Tabular Data Stream™) packets may benefit from disabling TCP packet batching. To disable TCP packet batching, set **tcp no delay** to 1.

➤ ***Note***

Disabling TCP packet batching means that packets will be sent, regardless of size; this will increase the volume of network traffic.

O/S Resources

The parameters in this group are related to Adaptive Server's use of operating system resources.

max async i/os per engine

Summary Information	
Name in pre-11.0 release	**cnmaxaio_engine**
Default value	2147483647
Range of values	1–2147483647
Status	Static
Display level	Comprehensive
Required role	System Administrator

max async i/os per engine specifies the maximum number of outstanding asynchronous disk I/O requests for a single engine at one time. See "max async i/os per server" on page 17-99 for more information.

max async i/os per server

Summary Information	
Name in pre-11.0 release	**cnmaxaio_server**
Default value	2147483647
Range of values	1–2147483647
Status	Static
Display level	Comprehensive
Required role	System Administrator

The **max async i/os per server** parameter specifies the maximum number of asynchronous disk I/O requests that can be outstanding for Adaptive Server at one time. This limit is not affected by the number of online engines per Adaptive Server; **max async i/os per server** limits the total number of asynchronous I/Os a server can issue at one time, regardless of how many online engines it has. **max async i/os per engine** limits the number of outstanding I/Os per engine.

Most operating systems limit the number of asynchronous disk I/Os that can be processed at any one time; some operating systems limit the number per operating system process, some limit the number per system, and some do both. If an application exceeds these limits, the operating system returns an error message. Because operating system calls are relatively expensive, it is inefficient for Adaptive Server to attempt to perform asynchronous I/Os that get rejected by the operating system.

To avoid this, Adaptive Server maintains a count of the outstanding asynchronous I/Os per engine and per server; if an engine issues an asynchronous I/O that would exceed either **max async i/os per engine** or **max async i/os per server**, Adaptive Server delays the I/O until enough outstanding I/Os have completed to fall below the exceeded limit.

For example, assume an operating system limit of 200 asynchronous I/Os per system and 75 per process and an Adaptive Server with three online engines. The engines currently have a total of 200 asynchronous I/Os pending, distributed according to the following table:

Engine	Number of I/Os Pending	Outcome
0	60	Engine 0 delays any further asynchronous I/Os until the total for the server is under the operating system **per-system** limit and then continues issuing asynchronous I/Os.
1	75	Engine 1 delays any further asynchronous I/Os until the per-engine total is under the operating system **per-process** limit and then continues issuing asynchronous I/Os.
2	65	Engine 2 delays any further asynchronous I/Os until the total for server is under the operating system **per-system** limit and then continues issuing asynchronous I/Os.

All I/Os (both asynchronous and synchronous) require a disk I/O structure, so the total number of outstanding disk I/Os is limited by the value of **disk i/o structures.** It is slightly more efficient for Adaptive Server to delay the I/O because it cannot get a disk I/O structure than because the I/O request exceeds **max i/os per server.** You should set **max async i/os per server** equal to the value of **disk i/o structures.** See “disk i/o structures” on page 17-40.

If the limits for asynchronous I/O can be tuned on your operating system, make sure they are set high enough for Adaptive Server. There is no penalty for setting them as high as needed.

Use **sp_sysmon** to see if the per server or per engine limits are delaying I/O on your system. If **sp_sysmon** shows that Adaptive Server exceeded the limit for outstanding requests per engine or per server, raise the value of the corresponding parameter. See the *Performance and Tuning Guide* for more information.

o/s file descriptors

Summary Information	
Name in pre-11.0 release	N/A
Default value	0
Range of values	Site-specific
Status	Read-only
Display level	Comprehensive
Required role	System Administrator

o/s file descriptors indicates the maximum per-process number of file descriptors configured for your operating system. This parameter is read-only and cannot be configured through Adaptive Server.

Many operating systems allow you to configure the number of file descriptors available per process. See your operating system documentation for further information on this.

The number of file descriptors available for Adaptive Server connections, which will be less than the value of **o/s file descriptors**, is stored in the variable *@@max_connections*. For more information on the number of file descriptors available for connections, see "Upper Limit to the maximum number of user connections" on page 17-165.

shared memory starting address

Summary Information	
Name in pre-11.0 release	**mrstart**
Default value	0
Range of values	Platform-specific
Status	Static
Display level	Comprehensive
Required role	System Administrator

shared memory starting address determines the virtual address where Adaptive Server starts its shared memory region.

It is unlikely that you will ever have to reconfigure **shared memory starting address**. You should do so only after consulting with Sybase Technical Support.

Parallel Queries

The following parameters configure Adaptive Server for parallel query processing – where the optimizer evaluates each query to determine whether it is eligible for parallel execution.

To determine the best values to use for the configuration parameters, and to understand how these values affect the optimizer, see Chapter 11, "Introduction to Parallel Query Processing," and Chapter 12, "Parallel Query Optimization," in the *Performance and Tuning Guide*.

number of worker processes, **max parallel degree**, and **max scan parallel degree** control parallel query processing at the server level. Using the **parallel_degree**, **process_limit_action**, and **scan_parallel_degree** options to the **set** command can limit parallel optimization at the session level, and using the **parallel** keyword of the **select** command can limit parallel optimization of specific queries. Figure 17-6 shows the precedence of the configuration parameters and session parameters.

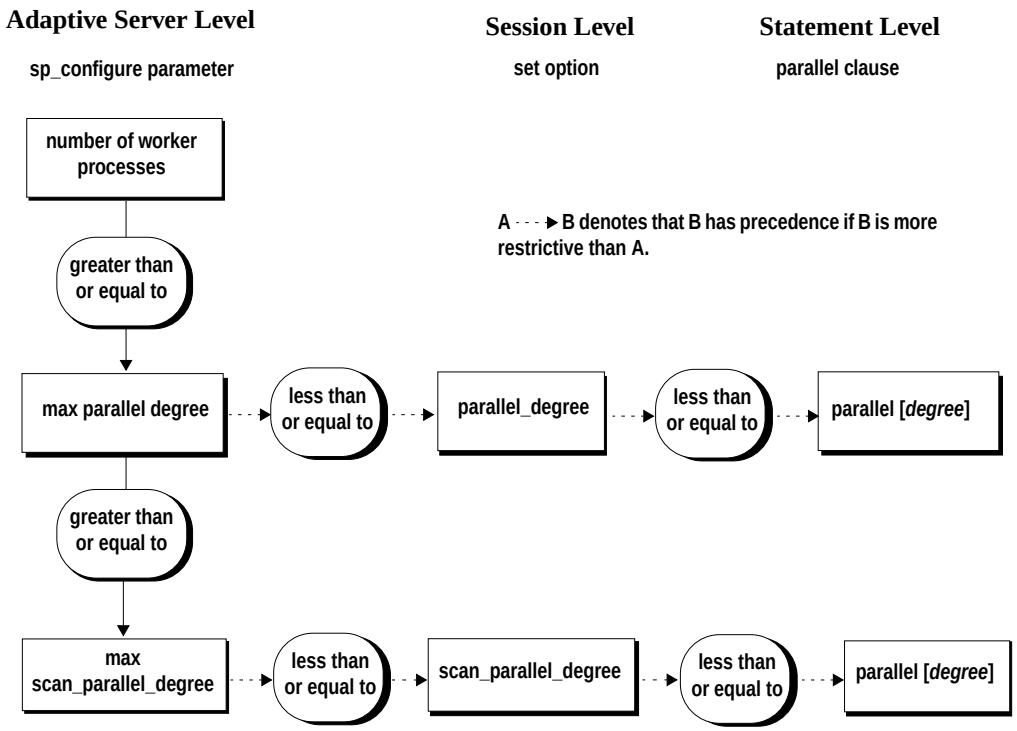


Figure 17-6: Precedence of parallel options

number of worker processes

Summary Information	
Name in pre-11.0 release	N / A
Default value	0
Range of values	0–2147483647
Status	Static
Display level	Basic
Required role	System Administrator

number of worker processes specifies the maximum number of worker processes that Adaptive Server can use at any one time for all simultaneously running parallel queries combined.

Adaptive Server issues a warning message at start-up if there is insufficient memory to create the specified number of worker processes. **memory per worker process** controls the memory allocated to each worker process.

max parallel degree

Summary Information	
Name in pre-11.0 release	N / A
Default value	1
Range of values	1–255
Status	Dynamic
Display level	Basic
Required role	System Administrator

max parallel degree specifies the server-wide maximum number of worker processes allowed per query. This is called the **maximum degree of parallelism**.

If this number is too low, the performance gain for a given query may not be as significant as it could be; if the number is too high, the server may compile plans that require more processes than are actually available at execution time, or the system may become

saturated, resulting in decreased throughput. To enable parallel partition scans, set this parameter to be equal to or greater than the number of partitions in the table you are querying.

The value of this parameter must be less than or equal to the current value of **number of worker processes.**

If you set **max parallel degree** to 1, Adaptive Server scans all tables or indexes serially.

Changing **max parallel degree** causes all query plans in the procedure cache to be invalidated, and new plans are compiled the next time you execute a stored procedure or trigger.

For more information on parallel sorting, see Chapter 13, "Parallel Sorting," in the *Performance and Tuning Guide*.

max scan parallel degree

Summary Information	
Name in pre-11.0 release	N / A
Default value	1
Range of values	1–255
Status	Dynamic
Display level	Basic
Required role	System Administrator

max scan parallel degree specifies the server-wide maximum degree of parallelism for hash-based scans. Hash-based scans may be used for the following access methods:

- Parallel index scans for partitioned and nonpartitioned tables
- Parallel table scans for nonpartitioned tables

max scan parallel degree applies per table or index; that is, if **max scan parallel degree** is 3, and one table in a join query is scanned using a hash-based table scan and the second can best be accessed by a hash-based index scan, the query could use 9 worker processes (as long as **max scan parallel degree** is set to 9 or higher.)

The optimizer uses this parameter as a guideline when it selects the number of processes to use for parallel, nonpartition-based scan operations. It does not apply to parallel sort. Because there is no partitioning to spread the data across devices, parallel processes can

be accessing the same device during the scan. This can cause additional disk contention and head movement, which can degrade performance. To prevent multiple disk accesses from becoming a problem, use this parameter to reduce the maximum number of processes that can access the table in parallel.

If this number is too low, the performance gain for a given query will not be as significant as it could be; if the number is too large, the server may compile plans that use enough processes to make disk access less efficient. A general rule of thumb is to set this parameter to no more than 2 or 3, because it takes only 2 to 3 worker processes to fully utilize the I/O of a given physical device.

Set the value of this parameter to less than or equal to the current value of **max parallel degree**. Adaptive Server returns an error if you specify a number larger than the **max parallel degree** value.

If you set **max scan parallel degree** to 1, Adaptive Server does not perform hash-based scans.

Changing **max scan parallel degree** causes all query plans in the procedure cache to be invalidated, and new plans are compiled the next time you execute a stored procedure or trigger.

memory per worker process

Summary Information	
Name in pre-11.0 release	N/A
Default value	1024
Range of values	1024–2147483647
Status	Static
Display level	Basic
Required role	System Administrator

memory per worker process specifies the amount of memory (in bytes) used by worker processes. Each worker process requires memory for messaging during query processing. This memory is allocated from a shared memory pool; the size of this pool is **memory per worker process** multiplied by **number of worker processes**. For most query processing, the default size is more than adequate. If you use **dbcc checkstorage**, and have set **number of worker processes** to 1, you may need to increase

memory per worker process to 1792 bytes. See the *Performance and Tuning Guide* for information on setting this parameter.

For more information on Adaptive Server's memory allocation, see Chapter 14, "Configuring Memory."

Physical Memory

The parameters in this group configure your machine's physical memory resources.

additional network memory

Summary Information	
Name in pre-11.0 release	**additional network memory**
Default value	0
Range of values	0–2147483647
Status	Static
Display level	Intermediate
Required role	System Administrator

additional network memory sets the maximum size of additional memory that can be used for network packets that are larger than the default packet size. Adaptive Server rounds down the value you enter to the nearest 2K value. The default value indicates that no extra space is allocated for large packets.

If you increase **max network packet size** but do not increase **additional network memory**, clients cannot use packet sizes that are larger than the default size, because all allocated network memory is reserved for users at the default size. Adaptive Server guarantees that every user connection can log in at the default packet size. In this situation, users who request a large packet size when they log in receive a warning message telling them that their application will use the default size.

Increasing **additional network memory** may improve performance for applications that transfer large amounts of data. To determine the value for **additional network memory** when your applications use larger packet sizes:

- Estimate the number of simultaneous users who will request the large packet sizes, and the sizes their applications will request,
- Multiply this sum by three, since each connection needs three buffers,
- Add two percent for overhead, and
- Round the value to the next highest multiple of 2048.

For example, if you estimate these simultaneous needs for larger packet sizes:

Application	Packet Size	Overhead
bcp	8192	
Client-Library	8192	
Client-Library	4096	
Client-Library	4096	
Total	24576	
Multiply by 3 buffers / user	*3	
	73728	
Compute 2% overhead		* .02=1474
Add overhead	+ 1474	
Additional network memory	75202	
Round up to multiple of 2048	75776	

you should set **additional network memory** to 75,776 bytes.

lock shared memory

Summary Information	
Name in pre-11.0 release	**T1611** (trace flag)
Default value	0 (off)
Valid values	0 (off), 1 (on)
Status	Static
Display level	Comprehensive
Required role	System Administrator

lock shared memory disallows swapping of Adaptive Server pages to disk and allows the operating system kernel to avoid the server's internal page locking code. This can reduce disk reads, which are expensive.

Not all platforms support shared memory locking. Even if your platform does, **lock shared memory** may fail due to incorrectly set permissions, insufficient physical memory, or for other reasons. See the configuration documentation for your platform for information on shared memory locking.

max SQL text monitored

Summary Information	
Name in pre-11.0 release	N / A
Default value	0
Range of values	0–2147483647
Status	Static
Display level	Comprehensive
Required role	System Administrator

max SQL text monitored specifies the amount of memory allocated per user connection for saving SQL text to memory shared by Adaptive Server Monitor.

Initially, the amount of memory allocated for saving text is 0, and since this parameter is static, you must restart Adaptive Server before you can start saving SQL Text.

If you do not allocate enough memory for the batch statements, the text you want to view may be in the section of the batch that is truncated. Sybase recommends an initial value of 1024 bytes of memory per user connection.

The total memory allocated from shared memory for the SQL text is the product of **max SQL text monitored** multiplied by the currently configured number of user connections.

For more information on **max SQL text monitored**, see “Configuring Adaptive Server to Save SQL Batch Text” on page 4-18.

total memory

Summary Information	
Name in pre-11.0 release	**memory**
Default value	Platform-specific
Range of values	Platform-specific minimum–2147483647
Status	Static
Display level	Intermediate
Required role	System Administrator

total memory sets the size of memory, in 2K units, that Adaptive Server allocates from the operating system. The default value of **total memory** varies from platform to platform. See the configuration documentation for your platform for the value on your operating system.

➤ ***Note***

The "Memory Used" column in the output reports all memory use in 1K (not 2K) units.

The more memory that is available, the more resources Adaptive Server has for internal buffers and caches, reducing the number of times the server has to read data from disk for static information or compiled procedure plans. There is no performance penalty for configuring Adaptive Server to use the maximum memory available to it on your computer. However, assess the other memory needs on your system, or Adaptive Server may not be able to acquire enough memory to start. See Chapter 14, "Configuring Memory," for instructions on how to maximize the amount of **total memory** for Adaptive Server.

If Adaptive Server Cannot Start

When Adaptive Server starts, it must acquire the full amount of memory, set by **total memory**, from the operating system. If Adaptive Server does not start because this amount of memory is not available to it, reduce the memory requirements for Adaptive Server by changing the value of **total memory** in the server's configuration file. You may also need to reduce the values for other configuration

parameters that require large amounts of memory. Then restart Adaptive Server to use the memory needed by the new values. If Adaptive Server fails to start because the total of other configuration parameter values is higher than the **total memory** value, see Chapter 14, "Configuring Memory," for information about configuration parameters that use memory.

Processors

The parameters in this group configure processors in an SMP environment.

max online engines

Summary Information	
Name in pre-11.0 release	**max online engines**
Default value	1
Range of values	1–128
Status	Static
Display level	Intermediate
Required role	System Administrator

max engines online specifies the maximum number of Adaptive Server engines that can be online at any one time in an SMP environment. See Chapter 16, "Managing Multiprocessor Servers," for a detailed discussion of how to set this parameter for your SMP environment.

At start-up, Adaptive Server starts with a single engine and completes its initialization, including recovery of all databases. Its final task is to allocate additional server engines. Each engine accesses common data structures in shared memory.

When tuning the **max engines online** parameter:

- Never have more online engines than there are CPUs.
- Depending on overall system load (including applications other than Adaptive Server), you may achieve optimal throughput by leaving some CPUs free to run non-Adaptive Server processes.

- Better throughput can be achieved by running fewer engines with high CPU use, rather than by running more engines with low CPU use.
- Scalability is application-dependent. You should conduct extensive benchmarks on your application to determine the best configuration of online engines.
- You can use the **dbcc engine** command to take engines offline or to bring them online line, but the number of engines must always be between **min online engines** and **max online engines.**

See "Taking Engines Offline with dbcc engine" on page 16-5 for information on using dbcc engine. See Chapter 37, "How Adaptive Server Uses Engines and CPUs," in the *Performance and Tuning Guide* for more information on performance and engine tuning.

min online engines

Summary Information	
Name in pre-11.0 release	**min online engines**
Default value	1
Range of values	1– **max online engines** setting
Status	Static
Display level	Intermediate
Required role	System Administrator

min online engines restricts the use of the **dbcc engine** command, so that it cannot be used to reduce the number of engines that are online below the configured value. **dbcc engine** allows taking engines offline without rebooting Adaptive Server. For example, if you set **max online engines** to 5, and **min online engines** to 3, the number of engines online can be reduced only to 3. See "Taking Engines Offline with dbcc engine" on page 16-5 for more information.

Rep Agent Thread Administration

The parameter in this group configures replication via Replication Server®.

enable rep agent threads

Summary Information	
Name in pre-11.0 release	N / A
Default value	0
Range of values	0–1
Status	Dynamic
Display level	Basic
Required role	System Administrator

enable rep agent threads enables the RepAgent thread within Adaptive Server.

Through version 11.0.3 of Replication Server, the Log Transfer Manager (LTM), a replication system component, transfers replication data to the Replication Server. Beginning with Replication Server versions later than 11.0.3, transfer of replication data handled by RepAgent, which will run as a thread under Adaptive Server. Setting **enable rep agent threads** enables this feature.

Other steps are also required to enable replication. For more information, see the Replication Server documentation.

SQL Server Administration

The parameters in this group are related to general Adaptive Server administration.

abstract plan cache

Summary Information	
Default value	0
Range of values	0–1
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

abstract plan cache enables caching of abstract plan hash keys. By default, caching is not enabled. For more information, see Chapter 22, "Creating and Using Abstract Plans," in the *Performance and Tuning Guide*. **abstract plan load** must be enabled in order for plan caching to take affect.

abstract plan dump

Summary Information	
Default value	0
Range of values	0–1
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

abstract plan dump enables the saving of abstract plans to the *ap_stdout* abstract plans group. For more information, see Chapter 22, "Creating and Using Abstract Plans," in the *Performance and Tuning Guide*.

abstract plan load

Summary Information	
Default value	0
Range of values	0–1
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

abstract plan load enables association of queries with abstract plans in the *ap_stdin* abstract plans group. For more information, see Chapter 22, "Creating and Using Abstract Plans," in the *Performance and Tuning Guide*.

abstract plan replace

Summary Information	
Default value	0
Range of values	0–1
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

abstract plan replace enables plan replacement for abstract plans in the *ap_stdout* abstract plans group. For more information, see Chapter 22, "Creating and Using Abstract Plans," in the *Performance and Tuning Guide*. **abstract plan load** must be enabled in order for replace mode to take effect.

allow backward scans

Summary Information	
Name in pre-11.0 release	N / A
Default value	1 (on)
Valid values	0 (off), 1 (on)
Status	Dynamic
Display level	Intermediate
Required role	System Administrator

allow backward scans controls how the optimizer performs **select** queries that contain the **order by...desc** command:

- When the value is set to 1, the optimizer can access the index or table rows by following the page chain in descending index order.
- When the value is set to 0, the optimizer selects the rows into a worktable by following the index page pointers in ascending order and then sorts the worktable in descending order.

The first method—performing backward scans—can speed access to tables that need results ordered by descending column values. Some applications, however, may experience deadlocks due to backward scans. In particular, look for increased deadlocking if you have **delete** or **update** queries that scan forward using the same index. There may also be deadlocks due to page splits in the index.

You can use **print deadlock information** to send messages about deadlocks to the error log. See “print deadlock information” on page 17-144. Alternatively, you can use **sp_sysmon** to check for deadlocking. See the *Performance and Tuning Guide* for more information on deadlocks.

allow nested triggers

Summary Information	
Name in pre-11.0 release	**nested trigger**
Default value	1 (on)
Valid values	0 (off), 1 (on)
Status	Static
Display level	Intermediate
Required role	System Administrator

allow nested triggers controls the use of nested triggers. When the value is set to 1, data modifications made by triggers can fire other triggers. Set **allow nested triggers** to 0 to disable nested triggers. A **set** option, **self_recursion**, controls whether the modifications made by a trigger can cause that trigger to fire again.

allow resource limits

Summary Information	
Name in pre-11.0 release	N / A
Default value	0 (off)
Valid values	0 (off), 1 (on)
Status	Static
Display level	Comprehensive
Required role	System Administrator

allow resource limits controls the use of resource limits. When the value is set to 1, the server allocates internal memory for time ranges, resource limits, and internal server alarms. The server also internally assigns applicable ranges and limits to user sessions. The output of **sp_configure** displays the optimizer's cost estimate for a query. Set **allow resource limits** to 0 to disable resource limits.

allow updates to system tables

Summary Information	
Name in pre-11.0 release	**allow updates**
Default value	0 (off)
Valid values	0 (off), 1 (on)
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

allow updates to system tables enables users with the System Administrator role to make changes to the system tables and to create stored procedures that can modify system tables. A database administrator can update system tables in any tables that he or she owns if **allow updates to system tables** is enabled.

System tables include:

- All Sybase-supplied tables in the *master* database
- All tables in user databases that begin with "sys" and that have an ID value in the *sysobjects* table of less than or equal to 100

◆ ***WARNING!***

Incorrect alteration of a system table can result in database corruption and loss of data. Always use begin transaction when modifying a system table to protect against errors that could corrupt your databases. Immediately after finishing your modifications, disable allow updates to system tables.

Stored procedures and triggers you create while **allow updates to system tables** is set on are always able to update the system tables, even after the parameter has been set off. When you set **allow updates to system tables** to on, you create a "window of vulnerability," a period of time during which users can alter system tables or create a stored procedure with which the system tables can be altered in the future.

Because the system tables are so critical, it is best to set this parameter to on only in highly controlled situations. To guarantee that no other users can access Adaptive Server while the system tables can be directly updated, restart Adaptive Server in single-user mode. For

details, see **startserver** and **dataserver** in the *Utility Programs* manual for your platform manual.

cpu accounting flush interval

Summary Information	
Name in pre-11.0 release	**cpu flush**
Default value	200
Range of values	1–2147483647
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

cpu accounting flush interval specifies the amount of time, in **machine** clock ticks, that Adaptive Server waits before flushing CPU usage statistics for each user from *sysprocesses* to *syslogins*, a procedure used in chargeback accounting. (Note that this is measured in **machine** clock ticks, not Adaptive Server clock ticks.)

When a user logs in to Adaptive Server, the server begins accumulating figures for CPU usage for that user process in *sysprocesses*. When a user logs off Adaptive Server, or when the value of **cpu accounting flush interval** is exceeded, the accumulated CPU usage statistics are flushed from *sysprocesses* to *syslogins*. These statistics continue accumulating in *syslogins* until you clear the totals using **sp_clearstats**. You can display the current totals from *syslogins* using **sp_reportstats**.

The value to which you set **cpu accounting flush interval** depends on the type of reporting you intend to do. If you intend to run reports on a monthly basis, set **cpu accounting flush interval** to a relatively high value. With infrequent reporting, it is less critical that the data in *syslogins* be updated as often.

On the other hand, if you intend to do periodic ad hoc selects on the *totcpu* column in *syslogins* to determine CPU usage by process, set **cpu accounting flush interval** to a lower value. Doing so increases the likelihood of the data in *syslogins* being up to date when you execute your selects.

Setting **cpu accounting flush interval** to a low value may cause processes to be mistakenly identified as potential deadlock victims by the lock

manager. When the lock manager detects a deadlock, it checks the amount of CPU time accumulated by each competing processes. The process with the lesser amount is chosen as the deadlock victim and is terminated by the lock manager. Additionally, when **cpu accounting flush interval** is set to a low value, the task handlers that store CPU usage information for processes are initialized more frequently, thus making processes appear as if they have accumulated less CPU time than they actually have. Because of this, the lock manager may select a process as the deadlock victim when, in fact, that process has more accumulated CPU time than the competing process.

If you do not intend to report on CPU usage at all, set **cpu accounting flush interval** to its maximum value. This reduces the number of times *syslogins* is updated and reduces the number of times its pages need to be written to disk.

cpu grace time

Summary Information	
Name in pre-11.0 release	**ctimemax**
Default value	500
Range of values	0–2147483647
Status	Static
Display level	Comprehensive
Required role	System Administrator

cpu grace time, together with **time slice**, specifies the maximum amount of time that a user process can run without yielding the CPU before Adaptive Server preempts it and terminates it with a time-slice error. The units for **cpu grace time** are time ticks, as defined by **sql server clock tick length**. See “sql server clock tick length” on page 17-148 for more information.

When a process exceeds **cpu grace time** Adaptive Server “infects” it by removing the process from the internal queues. The process is killed, but Adaptive Server is not affected. This prevents runaway processes from monopolizing the CPU. If any of your user processes become infected, you may be able to temporarily fix the problem by increasing the value of **cpu grace time**. However, you must be sure that the problem really is a process that takes more than the current value of **cpu grace time** to complete, rather than a runaway process.

Temporarily increasing the **cpu grace time** value is a workaround, not a permanent fix, since it may cause other complications; see "time slice" on page 17-149. Also, see Chapter 37, "How Adaptive Server Uses Engines and CPUs," and "Adaptive Server Execution Task Scheduling" on page 37-7 of the *Performance and Tuning Guide* for a more detailed discussion of task scheduling.

default database size

Summary Information	
Name in pre-11.0 release	**database size**
Default value	2
Range of values	2–10000
Status	Static
Display level	Intermediate
Required role	System Administrator

default database size sets the default number of megabytes allocated to a new user database if the **create database** statement is issued without any size parameters. A database size given in a **create database** statement takes precedence over the value set by this configuration parameter.

If most of the new databases on your Adaptive Server require more than 2MB, you may want to increase the default.

➤ ***Note***

If you alter the *model* database, you must also increase the **default database size** to make it more than 2MB, because the **create database** command copies *model* to create a new user database.

default fill factor percent

Summary Information	
Name in pre-11.0 release	**fillfactor**
Default value	0
Range of values	0–100
Status	Static
Display level	Intermediate
Required role	System Administrator

default fill factor percent determines how full Adaptive Server makes each index page when it is creating a new index on existing data, unless the fill factor is specified in the **create index** statement. The **fillfactor** percentage is relevant only at the time the index is created. As the data changes, the pages are not maintained at any particular level of fullness.

default fill factor percent affects:

- The amount of storage space used by your data – Adaptive Server redistributes the data as it creates the clustered index.
- Performance – splitting up pages uses Adaptive Server resources.

There is seldom a reason to change **default fill factor percent**, especially since you can override it in the **create index** command. For more information about the fill factor percentage, see **create index** in the *Adaptive Server Reference Manual*.

default exp_row_size percent

Summary Information	
Default value	5
Range of values	0–100
Status	Dynamic
Display level	Intermediate
Required role	System Administrator

default exp_row_size percent reserves space for expanding updates in data-only-locked tables, to reduce row forwarding. An **expanding update** is any update to a data row that increases the length of the row. Data rows that allow null values or that have variable-length columns may be subject to expanding updates. In data-only-locked tables, expanding updates can require row forwarding if the data row increases in size so that it no longer fits on the page.

The default valu , sets aside 5 percent of the available data page size for use by expanding updates. Since 2002 bytes are available for data storage on pages in data-only-locked tables, this leaves 100 bytes for expansion. This value is only applied to pages for tables that have variable-length columns.

Valid values are 0–99. Setting **default exp_row_size percent** to 0 means that all pages are completely filled and no space is left for expanding updates.

default exp_row_size percent is applied to data-only-locked tables with variable-length columns when **exp_row_size** is not explicitly provided with **create table** or set with **sp_chgattribute**. If a value is provided with **create table**, that value takes precedence over the configuration parameter setting. See the *Performance and Tuning Guide* for more information.

dump on conditions

Summary Information	
Name in pre-11.0 release	N / A
Default value	0
Range of values	0–1
Status	Dynamic
Display level	Intermediate
Required role	System Administrator

dump on conditions determines whether Adaptive Server generates a dump of data in shared memory when it encounters the conditions specified in **maximum dump conditions**.

➤ ***Note***

The **dump on conditions** parameter is included for use by Sybase Technical Support only. Do not modify it unless you are instructed to do so by Sybase Technical Support.

enable sort-merge joins and JTC

Summary Information	
Default value	0
Range of values	0–1
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

enable sort-merge joins and JTC configuration parameter determines whether merge joins and join transitive closure are considered by the query optimizer. By default, merge joins and join transitive closure are not enabled. To enable merge joins, set this parameter to 1.

Merge joins and join transitive closure can improve performance for queries that access large amounts of data, but increase optimization

time. The session-level options **set sort-merge on** and **set jtc on** take precedence over the server-wide setting. For more information, see "Enabling and Disabling Merge Joins" on page 20-12 and "Enabling and Disabling Join Transitive Closure" on page 20-13 in the *Performance and Tuning Guide*.

event buffers per engine

Summary Information	
Name in pre-11.0 release	N / A
Default value	100
Range of values	1–2147483647
Status	Static
Display level	Comprehensive
Required role	System Administrator

The **event buffers per engine** parameter specifies the number of events per Adaptive Server engine that can be monitored simultaneously by Adaptive Server Monitor. Events are used by Adaptive Server Monitor for observing Adaptive Server performance; if you are not using Adaptive Server Monitor, set this parameter to 1.

The value to which you set **event buffers per engine** depends on the number of engines in your configuration, the level of activity on your Adaptive Server, and the kinds of applications you are running.

Setting **event buffers per engine** to a low value may result in the loss of event information. The default value, is likely to be too low for most sites. Values of 2000 and above may be more reasonable for general monitoring. However, you need to experiment to determine the appropriate value for your site.

In general, setting **event buffers per engine** to a high value may reduce the amount of performance degradation that Adaptive Server Monitor causes Adaptive Server.

Each event buffer uses 100 bytes of memory. To determine the total amount of memory used by a particular value for **event buffers per engine**, multiply the value by the number of Adaptive Server engines in your configuration.

housekeeper free write percent

Summary Information	
Name in pre-11.0 release	N/A
Default value	1
Range of values	0–100
Status	Dynamic
Display level	Intermediate
Required role	System Administrator

housekeeper free write percent specifies the maximum percentage by which the housekeeper task can increase database writes.

For example, to stop the housekeeper task from working when the frequency of database writes reaches 5 percent above normal, set **housekeeper free write percent** to 5:

```
sp_configure "housekeeper free write percent", 5
```

When Adaptive Server has no user tasks to process, the housekeeper task automatically begins writing changed pages from cache to disk. These writes result in improved CPU utilization, decreased need for buffer washing during transaction processing, and shorter checkpoints.

In applications that repeatedly update the same database page, the housekeeper may initiate some unnecessary database writes. Although these writes occur only during the server's idle cycles, they may be unacceptable on systems with overloaded disks.

The table and index statistics that are used to optimize queries are maintained in memory structures during query processing. When these statistics change, the changes are not written to the *systabstats* table immediately, to reduce I/O contention and improve performance. Instead, the housekeeper task periodically flushes statistics to disk.

◆ ***WARNING!***

Setting housekeeper free write percent to 0 disables flushing statistics to the *systabstats* table. This can seriously impair performance if statistics change significantly.

The default value allows the housekeeper task to increase disk I/O by a maximum of 1 percent. This results in improved performance and recovery speed on most systems.

To disable the housekeeper task, set the value of **housekeeper free write percent** to 0:

```
sp_configure "housekeeper free write percent", 0
```

You should set this value to 0 only if disk contention on your system is high, and it cannot tolerate the extra I/O generated by the housekeeper.

If you disable the housekeeper tasks, be certain that statistics are kept current. Commands that write statistics to disk are:

- **update statistics**
- **dbcc checkdb** (for all tables in a database) or **dbcc checktable** (for a single table)
- **sp_flushstats**

You should run one of these commands on any tables that have been updated since the last time statistics were written to disk, at the following times:

- Before dumping a database
- Before an orderly shutdown
- After rebooting, following a failure or orderly shutdown; in these cases, you cannot use **sp_flushstats**, you must use **update statistics** or **dbcc** commands
- After any significant changes to a table, such as a large bulk copy operation, altering the locking scheme, deleting or inserting large numbers of rows, or a **truncate table** command

To allow the housekeeper task to work continuously, regardless of the percentage of additional database writes, set **housekeeper free write percent** to 100:

```
sp_configure "housekeeper free write percent", 100
```

Use **sp_sysmon** to monitor housekeeper performance. See the *Performance and Tuning Guide* for more information.

It might also be helpful to look at the number of free checkpoints initiated by the housekeeper task. The *Performance and Tuning Guide* describes this output.

enable HA

Summary Information	
Default value	0
Range of values	0–1
Status	Static
Display level	Comprehensive
Required role	System Administrator

Setting **enable HA** is set to 1 allows you to configure Adaptive Server as a companion server in a high availability subsystem. Adaptive Server use s Sybase's Failover to interact with the high availability subsystem. You must set enable HA to 1 before you run the *installhasvss* script (*insthasv* on Windows NT), which installs the system procedures for Sybase's Failover.

Note that, setting enable HA to 1 does not mean that Adaptive Server is configured to work in a high availabiltiy system. You must perform the steps described in *Using Sybase Failover in A High Availability System* to configure Adaptive Server to be a companion server in a high availability system.

When enable HA is set to 0, you cannot configure for Sybase's Failover, and you cannot run *installhasvss* (*insthasv* on Windows NT).

enable housekeeper GC

Summary Information	
Default value	1
Range of values	0–1
Status	Dynamic
Display level	Intermediate
Required role	System Administrator

When **enable housekeeper GC** is set to 1, the housekeeper task performs space reclamation on data-only-locked tables. **housekeeper free write percent** must also be set to 1; if it is set to zero, the housekeeper task is disabled. When a user task deletes a row from a data-only-locked

table, a task is queued to the housekeeper to check the data and index pages for committed deletes.

When **enable housekeeper GC** is set to 0, the housekeeper does not perform space reclamation. If all tables on your server use the allpages locking scheme, or if very few deletes or shrinking updates are performed on data-only-locked tables, setting **enable housekeeper GC** to 0 improves performance by slightly reducing housekeeper overhead. Use this setting:

- If you use only allpages locking
- If there are few deletes performed on your data-only-locked tables
- If your workload leaves little idle CPU time

sp_sysmon reports on how often the housekeeper task performed space reclamation and how many pages were reclaimed. See *Performance and Tuning Guide*.

identity burning set factor

Summary Information	
Name in pre-11.0 release	**identity burning set factor**
Default value	5000
Range of values	1–9999999
Status	Static
Display level	Intermediate
Required role	System Administrator

IDENTITY columns are of type *numeric* and scale zero whose values are generated by Adaptive Server. Column values can range from a low of 1 to a high determined by the column precision.

For each table with an IDENTITY column, Adaptive Server divides the set of possible column values into blocks of consecutive numbers, and makes one block at a time available in memory. Each time you insert a row into a table, Adaptive Server assigns the IDENTITY column the next available value from the block. When all the numbers in a block have been used, the next block becomes available.

This method of choosing IDENTITY column values improves server performance. When Adaptive Server assigns a new column value, it reads the current maximum value from memory and adds 1. Disk access becomes necessary only after all values within the block have been used. Because all remaining numbers in a block are discarded in the event of server failure (or **shutdown with nowait**), this method can lead to gaps in IDENTITY column values.

Use **identity burning set factor** to change the percentage of potential column values that is made available in each block. This number should be high enough for good performance, but not so high that gaps in column values are unacceptably large. The default value, 5000, releases .05 percent of the potential IDENTITY column values for use at one time.

To get the correct value for **sp_configure**, express the percentage in decimal form, and then multiply it by 10^7 (10,000,000). For example, to release 15 percent (.15) of the potential IDENTITY column values at a time, specify a value of .15 times 10^7 (or 1,500,000) in **sp_configure**:

```
sp_configure "identity burning set factor", 1500000
```

identity grab size

Summary Information	
Name in pre-11.0 release	N / A
Default value	1
Range of values	1–2147483647
Status	Dynamic
Display level	Intermediate
Required role	System Administrator

identity grab size allows each Adaptive Server process to reserve a block of IDENTITY column values for inserts into tables that have an IDENTITY column.

This is useful if you are doing inserts, and you want all the inserted data to have contiguous IDENTITY numbers. For instance, if you are entering payroll data, and you want all records associated with a particular department to be located within the same block of rows, set **identity grab size** to the number of records for that department.

identity grab size applies to all users on Adaptive Server. Large **identity grab size** values result in large gaps in the IDENTITY column when many users insert data into tables with IDENTITY columns.

Sybase recommends setting **identity grab size** to a value large enough to accommodate the largest group of records you want to insert into contiguous rows.

i/o accounting flush interval

Summary Information	
Name in pre-11.0 release	**i/o flush**
Default value	1000
Range of values	1–2147483647
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

i/o accounting flush interval specifies the amount of time, in **machine** clock ticks, that Adaptive Server waits before flushing I/O statistics for each user from *sysprocesses* to *syslogins*. This is used for chargeback accounting.

When a user logs in to Adaptive Server, the server begins accumulating I/O statistics for that user process in *sysprocesses*. When the value of **i/o accounting statistics interval** is exceeded, or a user logs off Adaptive Server, the accumulated I/O statistics for that user are flushed from *sysprocesses* to *syslogins*. These statistics continue accumulating in *syslogins* until you clear the totals by using **sp_clearstats**. You display the current totals from *syslogins* by using **sp_reportstats**.

The value to which you set **i/o accounting flush interval** depends on the type of reporting you intend to do. If you intend to run reports on a monthly basis, **i/o accounting flush interval** to a relatively high value. This is because, with infrequent reporting, it is less critical that the data in *syslogins* be updated frequently.

If you intend to do periodic ad hoc selects on the *totio* column *syslogins* to determine I/O volume by process, to set **i/o accounting flush interval** to a lower value. Doing so increases the likelihood of the data in *syslogins* being up to date when you execute your selects.

If you do not intend to report on I/O statistics at all, set **i/o accounting flush interval** to its maximum value. This reduces the number of times *syslogins* is updated and the number of times its pages need to be written to disk.

i/o polling process count

Summary Information	
Name in pre-11.0 release	**cmaxscheds**
Default value	10
Range of values	1–2147483647
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

i/o polling process count specifies the maximum number of processes that can be run by Adaptive Server before the scheduler checks for disk and/or network I/O completions. Tuning **i/o polling process count** affects both the response time and throughput of Adaptive Server.

Adaptive Server checks for disk or network I/O completions:

- If the number of tasks run since the last time Adaptive Server checked for I/O completions equals the value for **i/o polling process count**, and
- At every Adaptive Server clock tick.

As a general rule, increasing the value of **i/o polling process count** may increase throughput for applications that generate a lot of disk and network I/O. Conversely, decreasing the value may improve process response time in these applications, possibly at the risk of lowering throughput.

If your applications create both I/O and CPU-bound tasks, tuning **i/o polling process count** to a low value (1–2) ensures that I/O-bound tasks get access to CPU cycles.

For OLTP applications (or any I/O-bound application with user connections and short transactions), tuning **i/o polling process count** to a value in the range of 20–30 may increase throughput, but it may also increase response time.

When tuning **i/o polling process count**, consider three other parameters:

- **sql server clock tick length**, which specifies the duration of Adaptive Server's clock tick in microseconds. See "sql server clock tick length" on page 17-148.
- **time slice**, which specifies the number of clock ticks Adaptive Server's scheduler allows a user process to run. See "time slice" on page 17-149.
- **cpu grace time**, which specifies the maximum amount of time (in clock ticks) a user process can run without yielding the CPU before Adaptive Server preempts it and terminates it with a time-slice error. See "cpu grace time" on page 17-120.

Use **sp_sysmon** to determine the effect of changing the **i/o polling process count** parameter. See the *Performance and Tuning Guide* for more information.

page lock promotion HWM

Summary Information	
Default value	200
Range of values	2–2147483647
Status	Dynamic
Display level	Intermediate
Required role	System Administrator

page lock promotion HWM (high-water mark), together with the **page lock promotion LWM** (low-water mark) and **page lock promotion PCT** (percentage), specifies the number of page locks permitted during a single scan session of a page-locked table or index before Adaptive Server attempts to escalate from page locks to a table lock.

page lock promotion HWM sets a maximum number of page locks allowed on a table before Adaptive Server attempts to escalate to a table lock. When the number of page locks acquired during a scan session exceeds **page lock promotion HWM**, Adaptive Server attempts to acquire a table lock. The **page lock promotion HWM** value cannot be higher than **number of locks** value.

For more detailed information on scan sessions and setting up page lock promotion limits, see "Configuring Locks and Lock Promotion Thresholds," in Chapter 5, "Locking in Adaptive Server," in the *Performance and Tuning Guide*.

The default value for **page lock promotion HWM** is appropriate for most applications. You might want to raise the value to avoid table locking. For example, if you know that there are regular updates to 500 pages of an allpages-locked or datapages-locked table containing thousands of pages, you can increase concurrency for the tables by setting **page lock promotion HWM** to 500 so that lock promotion does not occur at the default setting of 200.

You can also configure lock promotion of page-locked tables and views at the per-object level. See **sp_setrowlockpromote** in the *Adaptive Server Reference Manual*.

Use **sp_sysmon** to see how changing **page lock promotion HWM** affects the number of lock promotions. **sp_sysmon** reports the ratio of exclusive page to exclusive table lock promotions and the ratio of shared page to shared table lock promotions. See "Lock Promotions" in Chapter 24, "Monitoring Performance with sp_sysmon," in the *Performance and Tuning Guide*.

page lock promotion LWM

Summary Information	
Default value	200
Range of values	2–value of **page lock promotion HWM**
Status	Dynamic
Display level	Intermediate
Required role	System Administrator

The **page lock promotion LWM** low-water mark) parameter, together with the **page lock promotion HWM** (high-water mark) and the **page lock promotion PCT**, specify the number of page locks permitted during a single scan session of a page locked table or an index before Adaptive Server attempts to promote from page locks to a table lock.

The **page lock promotion LWM** sets the number of page locks below which Adaptive Server does not attempt to issue a table lock on an object. The **page lock promotion LWM** must be less than or equal to **page lock promotion HWM**.

For more information on scan sessions and setting up lock promotion limits, see "Configuring Locks and Lock Promotion Thresholds," in Chapter 5, "Locking in Adaptive Server," in the *Performance and Tuning Guide*.

The default value for **page lock promotion LWM** is sufficient for most applications. If Adaptive Server runs out of locks (except for an isolated incident), you should increase **number of locks**. See the *Performance and Tuning Guide* for more information.

You can also configure page lock promotion at the per-object level. See **sp_setpglockpromote** in the *Adaptive Server Reference Manual*.

page lock promotion PCT

Summary Information	
Default value	100
Range of values	1–100
Status	Dynamic
Display level	Intermediate
Required role	System Administrator

If the number of locks held on an object is between **page lock promotion LWM** (low-water mark) and **page lock promotion HWM** (high-water mark). **page lock promotion PCT** sets the percentage of page locks (based on the table size) above which Adaptive Server attempts to acquire a table lock.

For more detailed information on setting up page lock promotion limits, see "Configuring Locks and Lock Promotion Thresholds," in Chapter 5, "Locking in Adaptive Server," in the *Performance and Tuning Guide*.

The default value for **page lock promotion PCT** is appropriate for most applications.

You can also configure lock promotion at the per-object level for page locked objects. See **sp_setpglockpromote** in the *Adaptive Server Reference Manual*.

maximum dump conditions

Summary Information	
Name in pre-11.0 release	N / A
Default value	10
Range of values	10–100
Status	Static
Display level	Intermediate
Required role	System Administrator

The **maximum dump conditions** parameter sets the maximum number of conditions you can specify under which Adaptive Server generates a dump of data in shared memory.

➤ ***Note***

This parameter is included for use by Sybase Technical Support only. Do not modify it unless you are instructed to do so by Sybase Technical Support.

number of alarms

Summary Information	
Name in pre-11.0 release	**cnalarm**
Default value	40
Range of values	40–2147483647
Status	Static
Display level	Comprehensive
Required role	System Administrator

number of alarms specifies the number of alarm structures allocated by Adaptive Server.

The Transact-SQL command **waitfor** defines a specific time, time interval, or event for the execution of a statement block, stored

procedure, or transaction. Adaptive Server uses alarms to execute **waitfor** commands correctly. Other internal processes require alarms.

When Adaptive Server needs more alarms than are currently allocated, this message is written to the error log:

```
uasetalarm: no more alarms available
```

The number of bytes of memory required for each is small. If you raise the **number of alarms value** significantly, you should adjust **total memory** accordingly.

number of aux scan descriptors

Summary Information	
Default value	200
Range of values	0–2147483647
Status	Static
Display level	Comprehensive
Required role	System Administrator

number of aux scan descriptors sets the number of auxiliary scan descriptors available in a pool shared by all users on a server.

Each user connection and each worker process has 48 scan descriptors exclusively allocated to it. Of these, 16 are reserved for user tables, 12 are reserved for worktables, and 20 are reserved for system tables (with 4 of these set aside for rollback conditions). A descriptor is needed for each table referenced, directly or indirectly, by a query. For user tables, a table reference includes the following:

- All tables referenced in the **from** clause of the query
- All tables referenced in a view named in the query (the view itself is not counted)
- All tables referenced in a subquery
- All tables that need to be checked for referential integrity (these are used only for inserts, updates, and deletes)
- A table created with **select...into**
- All worktables created for the query

If a table is referenced more than once (for example, in a self-join, in more than one view, or in more than one subquery) the table is

counted each time. If the query includes a **union**, each **select** statement in the **union** query is a separate scan. If a query runs in parallel, the coordinating process and each worker process needs a scan descriptor for each table reference.

When the number of user tables referenced by a query scan exceeds 16, or the number of worktables exceeds 12, scan descriptors from the shared pool are allocated. Data-only-locked tables also require a system table descriptor for each data-only-locked table accessed via a table scan (but not those accessed via an index scan). If more than 16 data-only-locked tables are scanned using table scans in a query, auxiliary scan descriptors are allocated for them.

If a scan needs auxiliary scan descriptors after it has used its allotted number, and there are no descriptors available in the shared pool, Adaptive Server displays an error message and rolls back the user transaction.

If none of your queries need additional scan descriptors, you may still want to leave **number of aux scan descriptors** set to the default value in case your system requirements grow. Set it to 0 only if you are sure that users on your system will not be running queries on more than 16 tables and that your tables have few or no referential integrity constraints. See "Monitoring Scan Descriptor Usage" on page 17-138 for more information.

If your queries need more scan descriptors, use one of the following methods to remedy the problem:

- Rewrite the query, or break it into steps using temporary tables. For data-only-locked tables, consider adding indexes if there are many table scans.
- Redesign the table's schema so that it uses fewer scan descriptors, if it uses a large number of referential integrity constraints. You can find how many scan descriptors a query would use by enabling **set showplan, noexec on** before running the query.
- Increase the **number of aux scan descriptors** setting.

The following sections describe how to monitor the current and high-water-mark usage with **sp_monitorconfig** to avoid running out of descriptors and how to estimate the number of scan descriptors you need.

Monitoring Scan Descriptor Usage

sp_monitorconfig reports the number of unused (free) scan descriptors, the number of auxiliary scan descriptors currently being used, the

percentage that is active, and the maximum number of scan descriptors used since the server was last started. Run it periodically, at peak periods, to monitor scan descriptor use.

This example output shows scan descriptor use with 500 descriptors configured:

```
sp_monitorconfig "aux scan descriptors"
Usage information at date and time: Jan 24 1997 9:54AM.

Name            # Free   # Active   % Active  # Max Ever Used   Re-used
--------------  --------  ------   --------   ---------------   -------
number of aux   260       240      48.00      427               NA
scan
descriptors
```

Only 240 auxiliary scan descriptors are being used, leaving 260 free. However, the maximum number of scan descriptors used at any one time since the last time Adaptive Server was started is 427, leaving about 20 percent for growth in use and exceptionally heavy use periods. “Re-used” does not apply to scan descriptors.

Estimating and Configuring Auxiliary Scan Descriptors

To get an estimate of scan descriptor use:

1. Determine the number of table references for any query referencing more than 16 user tables or those that have a large number of referential constraints, by running the query with **set showplan** and **set noexec** enabled. If auxiliary scan descriptors are required, **showplan** reports the number needed:

   ```
   Auxiliary scan descriptors required: 17
   ```

   The reported number includes all auxiliary scan descriptors required for the query, including those for all worker processes. If your queries involve only referential constraints, you can also use **sp_helpconstraint**, which displays a count of the number of referential constraints per table.

2. For each query that uses auxiliary scan descriptors, estimate the number of users who would run the query simultaneously and multiply. If 10 users are expected to run a query that requires 8 auxiliary descriptors, a total of 80 will be needed at any one time.

3. Add the per-query results to calculate the number of needed auxiliary scan descriptors.

Since changing **number of aux scan descriptors** requires a reboot, consider adding room for growth.

number of mailboxes

Summary Information	
Name in pre-11.0 release	**cnmbox**
Default value	30
Range of values	30–2147483647
Status	Static
Display level	Comprehensive
Required role	System Administrator

number of mailboxes specifies the number of mailbox structures allocated by Adaptive Server. Mailboxes, which are used in conjunction with messages, are used internally by Adaptive Server for communication and synchronization between kernel service processes. Mailboxes are not used by user processes. Do not modify this parameter unless instructed to do so by Sybase Technical Support.

number of messages

Summary Information	
Name in pre-11.0 release	**cnmsg**
Default value	64
Range of values	0–2147483647
Status	Static
Display level	Comprehensive
Required role	System Administrator

number of messages specifies the number of message structures allocated by Adaptive Server. Messages, which are used in conjunction with mailboxes, are used internally by Adaptive Server for communication and synchronization between kernel service processes. Messages are also used for coordination between a family of processes in parallel processing. Do not modify this parameter unless instructed to do so by Sybase Technical Support.

number of pre-allocated extents

Summary Information	
Name in pre-11.0 release	**cpreallocext**
Default value	2
Range of values	0–31
Status	Static
Display level	Comprehensive
Required role	System Administrator

number of pre-allocated extents specifies the number of extents (eight pages) allocated in a single trip to the page manager. Currently, it is used only by **bcp** to improve performance when copying in large amounts of data. By default, **bcp** allocates two extents at a time and writes an allocation record to the log each time.

Setting **number of pre-allocated extents** means that **bcp** allocates the specified number of extents each time it requires more space, and writes a single log record for the event. Setting the value to 0 disables extent allocation so that a single page is allocated each time bulk copy needs a page. Since each page allocation is logged, this can greatly increase the amount of transaction log space required.

An object may be allocated more pages than actually needed, so the value of **number of pre-allocated extents** should be low if you are using **bcp** for small batches. If you are using **bcp** for large batches, increase the value of **number of pre-allocated extents** to reduce the amount of overhead required to allocate pages and to reduce the number of log records.

number of sort buffers

Summary Information	
Name in pre-11.0 release	**csortbufsize**
Default value	500
Range of values	0–32767
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

number of sort buffers specifies the number of 2K buffers used to hold pages read from input tables and perform index merges during sorts.

Sybase recommends that you leave this parameter set to the default except when you are creating indexes in parallel. Setting the value too high can rob non-sorting processes of access to the 2K buffer pool in caches being used to perform sorts.

For more information on configuring this value for parallel **create index** statements, see "Configuring the number of sort buffers Parameter" on page 13-14 in the *Performance and Tuning Guide*.

partition groups

Summary Information	
Name in pre-11.0 release	N / A
Default value	1024
Range of values	1–2147483647
Status	Static
Display level	Comprehensive
Required role	System Administrator

partition groups specifies the maximum number of partition groups that can be allocated by Adaptive Server. Partition groups are internal structures used by Adaptive Server to control access to individual partitions of a table.

A partition group is composed of 16 partition caches, each of which stores information about a single partition. All caches in a partition group are used to store information about the same partitioned table. If a table has fewer than 16 partitions, the unused partition caches in that group are unused, and cannot be used by another table. If a table has more than 16 partitions, it requires multiple partition groups.

The default value allows a maximum 1024 open partition groups and a maximum of 16384 (1024 times 16) open partitions. The actual number of partitions may be slightly less, due to the grouping of partitions.

Adaptive Server allocates partition groups to a table when you partition the table or when you access it for the first time after restarting Adaptive Server. If there are not enough partition groups for the table, you will not be able to access or partition the table.

partition spinlock ratio

Summary Information	
Name in pre-11.0 release	N / A
Default value	10
Range of values	1–2147483647
Status	Static
Display level	Comprehensive
Required role	System Administrator

For Adaptive Servers running with multiple engines, **partition spinlock ratio** sets the number of rows in the internal partition caches that are protected by one **spinlock**.

Adaptive Server manages access to table partitions using internal **partition groups,** each of which contains partition caches. Each partition cache stores information about a partition (for example, the last page of the partition) that processes must use when accessing that partition.

By default, Adaptive Server systems are configured with **partition spinlock ratio** set to 10, or 1 spinlock for every 10 partition caches. Decreasing the value of **partition spinlock ratio** may have little impact on the performance of Adaptive Server. The default setting is correct for most servers.

For more information about configuring spinlock ratios, see “Configuring Spinlock Ratio Parameters” on page 16-9.

print deadlock information

Summary Information	
Name in pre-11.0 release	**T1204** (trace flag)
Default value	0 (off)
Valid values	0 (off), 1 (on)
Status	Dynamic
Display level	Intermediate
Required role	System Administrator

print deadlock information enables the printing of deadlock information to the error log.

If you are experiencing recurring deadlocks, setting **print deadlock information** to 1 provides you with information that can be useful in tracing the cause of the deadlocks. However, setting **print deadlock information** to 1 can seriously degrade Adaptive Server performance. For this reason, you should use it only when you are trying to determine the cause of deadlocks.

Use **sp_sysmon** output to determine whether deadlocks are occurring in your application. If they are, set **print deadlock information** to 1 to learn more about why they are occurring. See the *Performance and Tuning Guide* for more information.

runnable process search count

Summary Information	
Name in pre-11.0 release	**cschedspins**
Default value	2000
Range of values	0–2147483647
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

runnable process search count specifies the number of times an engine loops while looking for a runnable task before relinquishing the CPU to the operating system.

Adaptive Server engines check the run queue for runnable tasks whenever a task completes or exceeds its allotted time on the engine. At times, there will not be any tasks in the run queues. An engine can either relinquish the CPU to the operating system or continue to check for a task to run. Setting **runnable process search count** higher causes the engine to loop more times, thus holding the CPU for a longer time. Setting the **runnable process search count** lower causes the engine to release the CPU sooner.

If your machine is a uniprocessor that depends on helper threads to perform I/O, you may see some performance benefit from setting **runnable process search** order to perform network I/O, disk I/O, or other operating system tasks. If a client, such as a bulk copy operation, is running on the same machine as a single CPU server that uses helper threads, it can be especially important to allow both the server and the client access to the CPU.

For Adaptive Servers running on uniprocessor machines that do not use helper threads, and for multiprocessor machines, the default value provides good performance.

Use **sp_sysmon** to determine how the **runnable process search count** parameter affects Adaptive Server's use of CPU cycles, engine yields to the operating system, and blocking network checks. See the *Performance and Tuning Guide* for information.

size of auto identity column

Summary Information	
Name in pre-11.0 release	N / A
Default value	10
Range of values	1–38
Status	Dynamic
Display level	Intermediate
Required role	System Administrator

size of auto identity column sets the precision of IDENTITY columns that are automatically created with the **sp_dboption auto identity** and **unique auto_identity index** options.

The maximum value that can be inserted into an IDENTITY column is 10 $^{\text{PRECISION}}$ -1. After an IDENTITY column reaches its maximum value, all further **insert** statements return an error that aborts the current transaction.

If you reach the maximum value of an IDENTITY column, use the **create table** command to create a table that is identical to the old one, but with a larger precision for the IDENTITY column. After you have created the new table, use the **insert** command or **bcp** to copy data from the old table to the new one.

SQL Perfmon Integration (Windows NT Only)

Summary Information	
Name in pre-11.0 release	N / A
Default value	1 (on)
Valid values	0 (off), 1 (on)
Status	Static
Display level	Intermediate
Required role	System Administrator

SQL Perfmon Integration enables and disables the ability to monitor Adaptive Server statistics from the Windows NT Performance Monitor.

Adaptive Server must be registered as an NT Service to support monitor integration. This occurs automatically when:

- You start Adaptive Server using the Services Manager in the Sybase for Windows NT program group.
- You use the Services option in the Control Panel.
- You have configured Windows NT to start Adaptive Server as an automatic service.

See *Configuring Adaptive Server for Windows NT* for a list of the Adaptive Server counters you can monitor.

sql server clock tick length

Summary Information	
Name in pre-11.0 release	**cclkrate**
Default value	Platform-specific
Range of values	Platform-specific minimum–1000000, in multiples of default value
Status	Static
Display level	Comprehensive
Required role	System Administrator

sql server clock tick length specifies the duration of the server's clock tick, in microseconds. Both the default value and the minimum value are platform-specific. Adaptive Server rounds values up to an even multiple of *n*, where *n* is the platform-specific clock-tick default value. You can find the current values for **sql server clock tick length** by using **sp_helpconfig** or **sp_configure**.

In mixed-use applications with some CPU-bound tasks, decreasing the value of **sql server clock tick length** helps I/O-bound tasks. A value of 20,000 is reasonable for this. Shortening the clock tick length means that CPU-bound tasks will exceed the allotted time on the engine more frequently per unit of time, which allows other tasks greater access to the CPU. This may also marginally increase response times, because Adaptive Server runs its service tasks once per clock tick. Decreasing the clock tick length means that the service tasks will be run more frequently per unit of time.

Increasing **sql server clock tick length** favors CPU-bound tasks, because they execute longer between context switches. The maximum value of 1,000,000 may be appropriate for primarily CPU-bound applications. However, any I/O-bound tasks may suffer as a result. This can be mitigated somewhat by tuning **cpu grace time** (see "cpu grace time" on page 17-120) and **time slice** (see "time slice" on page 17-149).

➤ ***Note***

Changing the value of **sql server clock tick length** can have serious effects on Adaptive Server's performance. You should consult with Sybase Technical Support before resetting this value.

text prefetch size

Summary Information	
Name in pre-11.0 release	N / A
Default value	16
Valid values	0 to 65535
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

The **text prefetch size** parameter limits the number of pages of *text* and *image* data that can be prefetched into an existing buffer pool. Adaptive Server prefetches only *text* and *image* data that was created with Adaptive Server 12.x or was upgraded using **dbcc rebuild_text.**

time slice

Summary Information	
Name in pre-11.0 release	**time slice**
Default value	100
Range of values	50–1000
Status	Static
Display level	Comprehensive
Required role	System Administrator

time slice sets the number of milliseconds that Adaptive Server's scheduler allows a task to run. If **time slice** is set too low, Adaptive Server may spend too much time switching between tasks, which increases response time. If it is set too high, CPU-intensive tasks

might monopolize engines, which also increases response time. The default value, 100 milliseconds, allows each task to run for 1/10 of a second berfore relinquishing the CPU to another task.

See "cpu grace time" on page 17-120. Also, see Chapter 37, "How Adaptive Server Uses Engines and CPUs," and "Adaptive Server Execution Task Scheduling" on page 37-7 in the *Performance and Tuning Guide* for a more detailed discussion of task scheduling.

Use **sp_sysmon** to determine how **time slice** affects voluntary yields by Adaptive Server engines. See the *Performance and Tuning Guide* for more information.

upgrade version

Summary Information	
Name in pre-11.0 release	**upgrade version**
Default value	1101
Range of values	0–2147483647
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

upgrade version reports the version of the upgrade utility that upgraded your master device. The upgrade utility checks and modifies this parameter during an upgrade.

◆ ***WARNING!***

Although this parameter is configurable, you should not reset it. Doing so may cause serious problems with Adaptive Server.

You can determine whether an upgrade has been done on your master device by using **upgrade version** without specifying a value:

```
sp_configure "upgrade version"
```

row lock promotion HWM

Summary Information	
Default value	200
Range of values	2–2147483647
Status	Dynamic
Display level	Intermediate
Required role	System Administrator

row lock promotion HWM (high-water mark), together with **row lock promotion LWM** (low-water mark) and **row lock promotion PCT** specifies the number of row locks permitted during a single scan session of a table or an index before Adaptive Server attempts to escalate from row locks to a table lock.

row lock promotion HWM sets a maximum number of row locks allowed on a table before Adaptive Server attempts to escalate to a table lock. When the number of locks acquired during a scan session exceeds **row lock promotion HWM**, Adaptive Server attempts to acquire a table lock. The **lock promotion HWM** value cannot be higher than the **number of locks** value.

For more information on scan sessions and setting up lock promotion limits, see "Configuring Locks and Lock Promotion Thresholds," in Chapter 5, "Locking in Adaptive Server," in the *Performance and Tuning Guide*.

The default value for **row lock promotion HWM** is appropriate for most applications. You might want to raise the value to avoid table locking. For example, if you know that there are regular updates to 500 rows on a table that has thousands of rows, you can increase concurrency for the tables by setting **row lock promotion HWM** to around 500.

You can also configure row lock promotion at the per-object level. See **sp_setrowlockpromote** in the *Adaptive Server Reference Manual*.

row lock promotion LWM

Summary Information	
Default value	200
Range of values	2–value of **row lock promotion HWM**
Status	Dynamic
Display level	Intermediate
Required role	System Administrator

row lock promotion LWM (low-water mark), together with the **row lock promotion HWM** (high-water mark) and **row lock promotion PCT** specifies the number of row locks permitted during a single scan session of a table or an index before Adaptive Server attempts to promote from row locks to a table lock.

row lock promotion LWM sets the number of locks below which Adaptive Server does not attempt to acquire a table lock on the object. The **row lock promotion LWM** must be less than or equal to **row lock promotion HWM**.

For more detailed information on scan sessions and setting up lock promotion limits, see "Configuring Locks and Lock Promotion Thresholds," in Chapter 5 "Locking in Adaptive Server" in the *Performance and Tuning Guide*.

The default value for **row lock promotion LWM** is sufficient for most applications. If Adaptive Server runs out of locks (except for an isolated incident), you should increase **number of locks**. See the *Performance and Tuning Guide* for more information.

You can also configure lock promotion at the per-object level. See **sp_setrowlockpromote** in the *Adaptive Server Reference Manual*.

row lock promotion PCT

Summary Information	
Default value	100
Range of values	1–100
Status	Dynamic
Display level	Intermediate
Required role	System Administrator

If the number of locks held on an object is between **row lock promotion LWM** (low-water mark) and **row lock promotion HWM** (high-water mark), **row lock promotion PCT** sets the percentage of row locks (based on the number of rows in the table) above which Adaptive Server attempts to acquire a table lock.

For more information on setting up lock promotion limits, see "Configuring Locks and Lock Promotion Thresholds," in Chapter 5, "Locking in Adaptive Server," in the *Performance and Tuning Guide*.

The default value for **row lock promotion PCT** is appropriate for most applications.

You can also configure row lock promotion at the per-object level. See **sp_setrowlockpromote** in the *Adaptive Server Reference Manual*.

license information

Summary Information	
Default value	0
Valid values	$0–2^{31}$
Status	Dynamic
Display level	Comprehensive
Required role	System Administrator

license information allows Sybase System Administrators to monitor the number of user licenses used in Adaptive Server. Enabling this parameter only monitors the number of licenses issued; it does not enforce the license agreement.

If **license information** is set to 0, Adaptive Server does not monitor license use. If **license information** is set to a number greater than 0, the housekeeper task monitors the number of licenses used during the idle cycles in Adaptive Server. Set **license information** to the number of licenses specified in your license agreement.

If the number of licenses used is greater than the number to which **license information** is set, Adaptive Server writes the following error message to the error log:

```
WARNING: Exceeded configured number of user licenses
```

At the end of each 24-hour period, the maximum number of licenses used during that time is added to the *syblicenseslog* table. The 24-hour period restarts if Adaptive Server is restarted.

See "Monitoring License Use" on page 6-37 for more information.

Security Related

The parameters in this group configure security-related features.

allow procedure grouping

Summary Information	
Name in pre-11.0 release	N / A
Default value	1 (on)
Range of values	0 (off), 1 (on)
Status	Dynamic
Display level	Comprehensive
Required role	System Security Officer

allow procedure grouping controls the ability to group stored procedures of the same name so that they can be dropped with a single **drop procedure** statement. To run Adaptive Server in the **evaluated configuration**, you must prohibit stored procedure grouping by setting this option to 0. See **evaluated configuration** in the *Adaptive Server Glossary* for more information.

auditing

Summary Information	
Name in pre-11.0 release	N / A
Default value	0 (off)
Range of values	0 (off), 1 (on)
Status	Dynamic
Display level	Intermediate
Required role	System Security Officer

auditing enables or disables auditing for Adaptive Server.

audit queue size

Summary Information	
Name in pre-11.0 release	**audit queue size**
Default value	100
Range of values	1–65535
Status	Static
Display level	Intermediate
Required role	System Security Officer

The in-memory audit queue holds audit records generated by user processes until the records can be processed and written to the audit trail. A System Security Officer can change the size of the audit queue with **audit queue size**. There is a trade-off between performance and risk that must be considered when you configure the queue size. If the queue is too large, records can remain in it for some time. As long as records are in the queue, they are at risk of being lost if the system crashes. However, if the queue is too small, it can become full repeatedly, which affects overall system performance–user processes that generate audit records sleep if the audit queue is full.

Following are some guidelines for determining how big your audit queue should be. You must also take into account the amount of auditing to be done at your site.

- The memory requirement for a single audit record is 424 bytes; however a record can be as small as 22 bytes when it is written to a data page
- The maximum number of audit records that can be lost in a system crash is the size of the audit queue (in records), plus 20. After records leave the audit queue they remain on a buffer page until they are written to the current audit table on the disk. The pages are flushed to disk every 20 records at the most (less if the audit process is not constantly busy).
- In the system audit tables, the *extrainfo* field and fields containing names are of variable length, so audit records that contain complete name information are generally larger.

The number of audit records that can fit on a page varies from 4 to as many as 80 or more. The memory requirement for the default audit queue size of 100 is approximately 42K.

current audit table

Summary Information	
Name in pre-11.0 release	N / A
Default value	1
Range of values	0–8
Status	Dynamic
Display level	Intermediate
Required role	System Security Officer

current audit table establishes the table where Adaptive Server writes audit rows. A System Security Officer can change the current audit table, using:

```
sp_configure "current audit table", n
  [, "with truncate"]
```

where *n* is an integer that determines the new current audit table, as follows:

- 1 means *sysaudits_01*, 2 means *sysaudits_02*, and so forth, up to 8.
- 0 tells Adaptive Server to set the current audit table to the next table. For example, if your installation has three audit tables,

sysaudits_01, *sysaudits_02*, and *sysaudits_03*, Adaptive Server sets the current audit table to:

- 2 if the current audit table is *sysaudits_01*
- 3 if the current audit table is *sysaudits_02*
- 1 if the current audit table is *sysaudits_03*

"with truncate" specifies that Adaptive Server should truncate the new table if it is not already empty. **sp_configure** fails if this option is not specified and the table is not empty.

➤ ***Note***

If Adaptive Server truncates the current audit table, and you have not archived the data, the table's audit records are lost. Be sure that the audit data is archived before using the **with truncate** option.

To execute **sp_configure** to change the current audit table, you must have the **sso_role** active. You can write a threshold procedure to change the current audit table automatically.

max roles enabled per user

Summary Information	
Name in pre-11.0 release	N / A
Default value	20
Range of values	10–127
Status	Static
Display level	Intermediate
Required role	System Security Officer

max roles enabled per user sets the number of roles you can activate per user session.

The maximum number of roles server-wide is 1024. The maximum number of user-defined roles you can activate server-wide is 992. This is because the first 32 roles are reserved for Sybase system roles.

msg confidentiality reqd

Summary Information	
Name in pre-11.0 release	N / A
Default value	0 (off)
Range of values	0 (off), 1 (on)
Status	Dynamic
Display level	Intermediate
Required role	System Security Officer

The **msg confidentiality reqd** parameter requires that all messages into and out of Adaptive Server be encrypted. The **use security services** parameter must be 1 for messages to be encrypted.

msg integrity reqd

Summary Information	
Name in pre-11.0 release	N / A
Default value	0 (off)
Range of values	0 (off), 1 (on)
Status	Dynamic
Display level	Intermediate
Required role	System Security Officer

msg integrity reqd requires that all messages be checked for data integrity. **use security services** must be 1 for message integrity checks to occur. If **msg integrity reqd** is set to one, Adaptive Server allows the client connection to succeed unless the client is using one of the following security services: **message integrity, replay detection**, **origin checks,** or **out-of-seq checks.**

secure default login

Summary Information	
Name in pre-11.0 release	N / A
Default value	0
Range of values	0 (followed by another parameter naming the default login)
Status	Dynamic
Display level	Intermediate
Required role	System Security Officer

secure default login specifies a default login for all users who are preauthenticated but who do not have a login in *master..syslogins*.

Establish the secure default login with:

```
sp_configure "secure default login", 0,
    default_login_name
```

where:

- **secure default login** is the name of the parameter.
- **0** is a required parameter because the second parameter of **sp_configure** must be a numeric value.
- *default_login_name* is the name of the default login for a user who is unknown to Adaptive Server, but who has already been authenticated by a security mechanism. The login name must be a valid login in *master..syslogins*.

For example, to specify “dlogin” as the secure default login, type:

```
sp_configure "secure default login", 0, dlogin
```

select on syscomments.text column

Summary Information	
Name in pre-11.0 release	N / A
Default value	1
Range of values	0–1
Status	Dynamic
Display level	Comprehensive
Required role	System Security Officer

This parameter enables protection of the text of database objects through restriction of the **select** permission on the *text* column of the *syscomments* table. The default value of 1 allows **select** permission to "public." Set the option to 0 to restrict **select** permission to the object owner and the System Administrator.

To run Adaptive Server in the **evaluated configuration**, you must protect the source text of database objects by setting this option to 0.

See **evaluated configuration** in the *Adaptive Server Glossary* for more information.

suspend audit when device full

Summary Information	
Name in pre-11.0 release	N / A
Default value	1
Range of values	0–1
Status	Dynamic
Display level	Intermediate
Required role	System Security Officer

suspend audit when device full determines what Adaptive Server does when an audit device becomes completely full.

➤ ***Note***

If you have two or more audit tables, each on a separate device other than the master device, and you have a threshold procedure for each audit table segment, the audit devices should never become full. Only if a threshold procedure is not functioning properly would the "full" condition occur.

Choose one of these values:

- 0 – truncates the next audit table and starts using it as the current audit table when the current audit table becomes full. If you set the parameter to 0, you ensure that the audit process is never suspended. However, you incur the risk that older audit records will get lost if they have not been archived.
- 1 – suspends the audit process and all user processes that cause an auditable event. To resume normal operation, the System Security Officer must log in and set up an empty table as the current audit table. During this period, the System Security Officer is exempt from normal auditing. If the System Security Officer's actions would generate audit records under normal operation, Adaptive Server sends an error message and information about the event to the error log.

To run in the evaluated configuration, set this parameter to 1. See **evaluated configuration** in the *Adaptive Server Glossary* for more information.

systemwide password expiration

Summary Information	
Name in pre-11.0 release	**password expiration interval**
Default value	0
Range of values	0–32767
Status	Dynamic
Display level	Intermediate
Required role	System Security Officer

systemwide password expiration, which can be set only by a System Security Officer, sets the number of days that passwords remain in effect after they are changed. If **systemwide password expiration** is set to 0,

passwords do not expire. If it is set to a number greater than 0, all passwords expire after the specified number of days. An account's password is considered expired if an interval greater than *number_of_days* has passed since the last time the password for that account was changed.

When the number of days remaining before expiration is less than 25 percent of the value of **systemwide password expiration** or 7 days, whichever is greater, each time the user logs in, a message displays, giving the number of days remaining before expiration. Users can change their passwords anytime before expiration.

When an account's password has expired, the user can still log in to Adaptive Server but cannot execute any commands until he or she has used **sp_password** to change his or her password. If the System Security Officer changes the user's password while the account is in **sp_password**-only mode, the account returns to normal after the new password is assigned.

This restriction applies only to login sessions established after the password has expired. Users who are logged in at the time their passwords expire are not affected until the next time they log in.

unified login required (Windows NT Only)

Summary Information	
Name in pre-11.0 release	N / A
Default value	0
Range of values	0, 1
Status	Dynamic
Display level	Intermediate
Required role	System Security Officer

unified login required requires that all users who log in to Adaptive Server be authenticated by the Windows NT LAN Manager. The **use security services** parameter must be 1 to use the unified login security service.

unified login required

Summary Information	
Name in pre-11.0 release	N / A
Default value	0
Range of values	0, 1
Status	Dynamic
Display level	Intermediate
Required role	System Security Officer

unified login required requires that all users who log in to Adaptive Server be authenticated by a security mechanism. **use security services** must be 1 to use the unified login security service.

use security services (Windows NT Only)

Summary Information	
Name in pre-11.0 release	N / A
Default value	0
Range of values	0, 1
Status	Static
Display level	Intermediate
Required role	System Security Officer

use security services specifies that Adaptive Server will use security services provided by Windows NT LAN Manager. If the parameter is set to 0, unified login services with the LAN Manager cannot be used.

use security services

Summary Information	
Name in pre-11.0 release	N / A
Default value	0
Range of values	0, 1
Status	Static
Display level	Intermediate
Required role	System Security Officer

use security services specifies that Adaptive Server will use network-based security services. If the parameter is set to 0, none of the network-based security services can be used.

User Environment

The parameters in this group configure user environments.

number of user connections

Summary Information	
Name in pre-11.0 release	**user connections**
Default value	25
Range of values	5–2147483647
Status	Static
Display level	Basic
Required role	System Administrator

number of user connections sets the maximum number of user connections that can be connected to Adaptive Server at the same time. It does not refer to the maximum number of processes; that number depends not only on the value of this parameter but also on other system activity.

Upper Limit to the *maximum number of user connections*

The maximum allowable number of file descriptors per process is operating-system-dependent; see the configuration documentation for your platform.

The number of file descriptors available for Adaptive Server connections is stored in the global variable *@@max_connections*. You can report the maximum number of file descriptors your system can use with:

```
select @@max_connections
```

The return value represents the maximum number of file descriptors allowed by the system for your processes, minus overhead. Overhead increases with the number of engines. For more information on how multiprocessing affects the number file descriptors available for Adaptive Server connections, see "Managing User Connections" on page 16-8.

In addition, you must reserve a number of connections for the following items, which you also set with configuration parameters:

- The database devices, including mirror devices
- Site handlers
- Network listeners

The following formula determines how high you can set **number of user connections**, **number of devices**, **max online engines**, **number of remote sites**, and **max number network listeners**:

number of user connections + (**number of devices** * **max online engines** * 2) + **number of remote sites** + **max number network listeners** cannot be greater than the value of *@@max_connections*.

Optimizing the Value of the *max number of user connections* Parameter

There is no formula for determining how many connections to allow for each user. You must estimate this number, based on the system and user requirements described here. You must also take into account that on a system with many users, there is more likelihood that connections needed only occasionally or transiently can be shared among users. The following processes require user connections:

- One connection is needed for each user running **isql**.
- Application developers use one connection for each editing session.

- The number of connections required by users running an application depends on how the application has been programmed. Users executing Open Client programs need one connection for each open DB-Library **dbprocess** or Client-Library **cs_connection.**

➤ ***Note***

It is a good idea to estimate the maximum number of connections that will be used by Adaptive Server and to update **number of user connections** as you add physical devices or users to the system. Use **sp_who** periodically to determine the number of active user connections on your Adaptive Server.

Certain other configuration parameters, including **stack size** and **default network packet size**, affect the amount of memory for each user connection.

permission cache entries

Summary Information	
Name in pre-11.0 release	**cfgcprot**
Default value	15
Range of values	1–2147483647
Status	Static
Display level	Comprehensive
Required role	System Administrator

permission cache entries determines the number of cache protectors per task. This parameter increases the amount of memory for each user connection and worker process.

Information about user permissions is held in the permission cache. When Adaptive Server checks permissions, it looks first in the permission cache; if it does not find what it needs, it looks in the *sysprotects* table. It is significantly faster if Adaptive Server finds the information it needs in the permission cache and does not have to read *sysprotects.*

However, Adaptive Server looks in the permission cache only when it is checking user permissions, not when permissions are being granted or revoked. When a permission is granted or revoked, the

entire permission cache is flushed. This is because existing permissions have timestamps that become outdated when new permissions are granted or revoked.

If users on your Adaptive Server frequently perform operations that require their permissions to be checked, you may see a small performance gain by increasing the value of **permission cache entries**. This effect is not likely to be significant enough to warrant extensive tuning.

If users on your Adaptive Server frequently grant or revoke permissions, avoid setting **permission cache entries** to a large value. The space used for the permission cache would be wasted, since the cache is flushed with each **grant** and **revoke** command.

stack guard size

Summary Information	
Name in pre-11.0 release	**cguardsz**
Default value	4096
Range of values	0–2147483647
Status	Static
Display level	Comprehensive
Required role	System Administrator

stack guard size sets the size (in bytes) of the stack guard area. The **stack guard area** is an overflow stack of configurable size at the end of each stack. Adaptive Server allocates one stack for each user connection and worker process when it starts. These stacks are located contiguously in the same area of memory, with a guard area at the end of each stack. At the end of each stack guard area is a **guardword**, which is a 4-byte structure with a known pattern. Figure 17-7 illustrates how a process can corrupt a stack guardword.

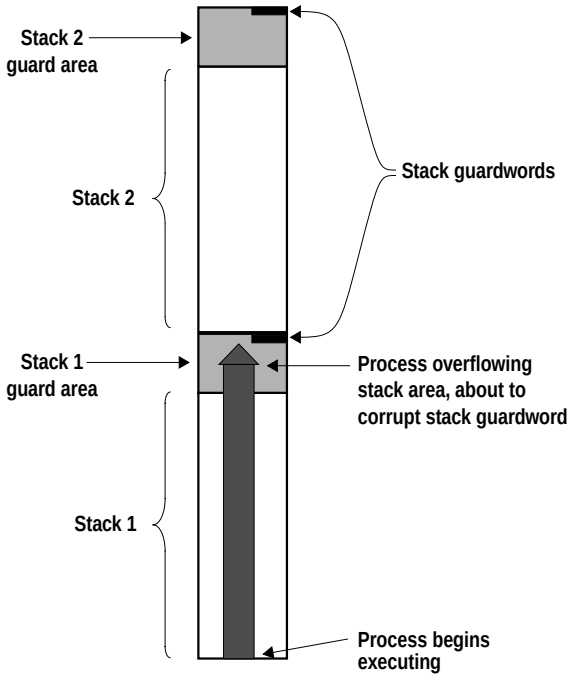


Figure 17-7: Process about to corrupt stack guardword

Adaptive Server periodically checks to see whether the stack pointer for a user connection has entered the stack guard area associated with that user connection's stack. If it has, Adaptive Server aborts the transaction, returns control to the application that generated the transaction, and generates Error 3626:

```
The transaction was aborted because it used too
much stack space.  Either use sp_configure to
increase the stack size, or break the query into
smaller pieces. spid: %d, suid: %d, hostname:
%.*s, application name: %.*s
```

Adaptive Server also periodically checks the guardword pattern to see if it has changed, thus indicating that a process has overflowed the stack boundary. When this occurs, Adaptive Server prints these messages to the error log and shuts down:

```
kernel: *** Stack overflow detected: limit: 0x%lx sp: 0x%lx
kernel: *** Stack Guardword corrupted
kernel: *** Stack corrupted, server aborting
```

In the first message, "limit" is the address of the end of the stack guard area, and "sp" is the current value of the stack pointer.

In addition, Adaptive Server periodically checks the stack pointer to see whether it is completely outside both the stack and the stack guard area for the pointer's process. If it is, Adaptive Server shuts down, even if the guardword is not corrupted. When this happens, Adaptive Server prints the following messages to the error log:

```
kernel: *** Stack overflow detected: limit: 0x%lx sp: 0x%lx
kernel: *** Stack corrupted, server aborting
```

The default value for **stack guard size** is appropriate for most applications. However, if you experience server shutdown from either stack guardword corruption or stack overflow, increase **stack guard size** by a 2K increment. **Each** configured user connection and worker process has a stack guard area; thus, when you increase **stack guard size**, you use up that amount of memory, multiplied by the number of user connections and worker processes you have configured.

Rather than increasing **stack guard size** to avoid stack overflow problems, consider increasing **stack size** (see "stack size" on page 17-170). The stack guard area is intended as an overflow area, not as an extension to the regular stack.

Adaptive Server allocates stack space for each task by adding the values of the **stack size** and **stack guard size** parameters. **stack guard size** must be configured in multiples of 2K. If the value you specify is not a multiple of 2K, **sp_configure** verification routines round the value up to the next highest multiple.

stack size

Summary Information	
Name in pre-11.0 release	**stack size**
Default value	platform-specific
Range of values	Platform-specific minimum–2147483647
Status	Static
Display level	Basic
Required role	System Administrator

stack size specifies the size (in bytes) of the execution stacks used by each user process on Adaptive Server. To find the **stack size** values for your platform, use **sp_helpconfig** or **sp_configure**. **stack size** must be configured in multiples of 2K. If the value you specify is not a multiple of 2K, **sp_configure** verification routines round the value up to the next highest multiple.

An **execution stack** is an area of Adaptive Server memory where user processes keep track of their process context and store local data.

Certain queries can contribute to the probability of a stack overflow. Examples include queries with extremely long **where** clauses, long select lists, deeply nested stored procedures, and multiple selects and updates using **holdlock**. When a stack overflow occurs, Adaptive Server prints an error message and rolls back the transaction. See “stack guard size” on page 17-167 for more information on stack overflows. See the *Adaptive Server Error Messages* manual for more information on specific error messages.

The two options for remedying stack overflows are to break the large queries into smaller queries and to increase **stack size**. Changing **stack size** affects the amount of memory required for **each** configured user connection and worker process. See “total memory” on page 17-110 for further information.

If you have queries that exceed the size of the execution stack, you may want to rewrite them as a series of smaller queries. This is particularly true if there are only a small number of such queries or if you run them infrequently.

There is no way to determine how much stack space a query will require without actually running the query. Stack space for each user connection and worker process is preallocated at start-up.

Therefore, determining the appropriate value for **stack size** is an empirical process. You should test your largest and most complex queries using the default value for **stack size**. If they run without generating error messages, the default is probably sufficient. If they generate error messages, you should begin by increasing **stack size** by a small amount (2K). Rerun your queries and see if the amount you have added is sufficient. If it is not, continue to increase **stack size** until queries run without generating error messages.

If Java is enabled in the database and you want to use methods that call JDBC, the minimum recommended stack size is 51200 bytes. If you are not using JDBC, the standard default value is sufficient.

user log cache size

Summary Information	
Name in pre-11.0 release	N / A
Default value	2048
Range of values	2048–2147483647
Status	Static
Display level	Intermediate
Required role	System Administrator

user log cache size specifies the size (in bytes) for each user's log cache. There is one user log cache for each configured user connection and worker process. Adaptive Server uses these caches to buffer the user transaction log records, which reduces the contention at the end of the transaction log.

When a user log cache becomes full or another event occurs (such as when the transaction completes), Adaptive Server "flushes" all log records from the user log cache to the database transaction log. By first consolidating the log records in each user's log cache, rather than immediately adding each record to the database's transaction log, Adaptive Server reduces contention of processes writing to the log, especially for SMP systems configured with more than one engine.

➤ ***Note***

For transactions using a database with mixed data and log segments, the user log cache is flushed to the transaction log after each log record. No buffering takes place. If your databases do not have dedicated log segments, you should not increase the user log cache size.

Do not configure **user log cache size** to be larger than the maximum amount of log information written by an application's transaction. Since Adaptive Server flushes the user log cache when the transaction completes, any additional memory allocated to the user log cache is wasted. If no transaction in your server generates more than 4000 bytes of transaction log records, set **user log cache size** no higher than that value. For example:

```
sp_configure "user log cache size", 4000
```

Setting **user log cache size** too high wastes memory. Setting it too low can cause the user log cache to fill up and flush more than once per transaction, increasing the contention for the transaction log. If the volume of transactions is low, the amount of contention for the transaction log may not be significant.

Use **sp_sysmon** to understand how this parameter affects cache behavior. See the *Performance and Tuning Guide* for more information.

user log cache spinlock ratio

Summary Information	
Name in pre-11.0 release	N / A
Default value	20
Range of values	1–2147483647
Status	Static
Display level	Intermediate
Required role	System Administrator

For Adaptive Servers running with multiple engines, the **user log cache spinlock ratio** parameter specifies the ratio of user log caches per user log cache **spinlock**. There is one user log cache for each configured user connection.

The default value for this parameter is 20, or one spinlock for each 20 user connections configured for your server.

Use **sp_sysmon** to understand how this parameter affects cache behavior. See the *Performance and Tuning Guide* for more information.

For more information about configuring spinlock ratios, see "Configuring Spinlock Ratio Parameters" on page 16-9.

18 Limiting Access to Server Resources

This chapter describes how to use resource limits to restrict the I/O cost, row count, or processing time that an individual login or application can use during critical times. It also describes how to create named time ranges to specify contiguous blocks of time for resource limits. Topics include:

What Are Resource Limits?

Adaptive Server provides resource limits to help System Administrators prevent queries and transactions from monopolizing server resources. A **resource limit** is a set of parameters specified by a System Administrator to prevent an individual login or application from:

- Exceeding estimated or actual I/O costs, as determined by the optimizer
- Returning more than a set number of rows
- Exceeding a given elapsed time

The set of parameters for a resource limit includes the time of day to enforce the limit and the type of action to take. For example, you can prevent huge reports from running during critical times of the day, or kill a session whose query produces unwanted **Cartesian products**.

Planning Resource Limits

In planning a resource limit, consider:

- When to impose the limit (times of day and days of the week)
- Which users and applications to monitor
- What type of limit to impose
  - I/O cost (estimated or actual) for queries that may require large numbers of logical and physical reads
  - Row count for queries that may return large result sets
  - Elapsed time for queries that may take a long time to complete either because of their own complexity or because of external factors such as server load
- Whether to apply a limit to individual queries or to specify a broader scope (query batch or transaction)
- Whether to enforce the I/O cost limits prior to or during execution
- What action to take when the limit is exceeded (issue a warning, abort the query batch or transaction, or kill the session)

After completing the planning, use system procedures to:

- Specify times for imposing the limit by creating a named time range using **sp_add_time_range**
- Create new resource limits using **sp_add_resource_limit**
- Obtain information about existing resource limits using **sp_help_resource_limit**
- Modify time ranges and resource limits using **sp_modify_time_range** and **sp_modify_resource_limit**, respectively
- Drop time ranges and resource limits using **sp_drop_time_range** and **sp_drop_resource_limit**, respectively

Enabling Resource Limits

Configure Adaptive Server to enable resource limits. Use **allow resource limits** configuration parameter:

```
sp_configure "allow resource limits", 1
```

1 enables the resource limits; 0 disables them. **allow resource limits** is static, so you must restart the server to reset the changes.

allow resource limits signals the server to allocate internal memory for time ranges, resource limit, s and internal server alarms. It also internally assigns applicable ranges and limits to login sessions.

Setting **allow resource limits** to 1 also changes the output of **showplan** and **statistics i/o**, as follows:

- **showplan** displays estimated I/O cost information for DML statements. The information displayed is the optimizer's cost estimate for the query as a unitless number. The total estimated I/O cost is displayed for the query as a whole. This cost estimate is dependent on the table statistics (number and distribution of values) and the size of the appropriate buffer pools. It is independent of such factors as the state of the buffer pools and the number of active users. For more information, see "showplan Messages Describing Access Methods, Caching, and I/O Cost" in the *Performance and Tuning Guide*.
- **statistics io** includes the actual total I/O cost of a statement according to the optimizer's costing formula. This value is a number representing the sum of the number of logical I/Os multiplied by the cost of a logical I/O and the number of physical I/Os multiplied by the cost of a physical I/O. For more information on these numbers, see "How Is "Fast" Determined?" in the *Performance and Tuning Guide*.

Defining Time Ranges

A **time range** is a contiguous block of time within a single day across one or more contiguous days of the week. It is defined by its starting and ending periods.

Adaptive Server includes predefined "at all times" range, which covers the period midnight through midnight, Monday through Sunday. You can create, modify, and drop additional time ranges as necessary for resource limits.

Named time ranges may overlap. However, the limits for a particular user/application combination may not be associated with named time ranges that overlap. You can create different limits that share the same time range.

For example, assume that you limit "joe_user" to returning 100 rows when he is running the payroll application during business hours. Later, you attempt to limit his row retrieval during peak hours, which overlap with business hours. You will get a message that the

new limit failed, because it would have overlapped with an existing limit.

Although you cannot limit the row retrieval for "joe_user" in the payroll application during overlapping time ranges, nothing stops you from putting a second limit on "joe_user" during the same time range as the row retrieval limit. For example, you can limit the amount of time one of his queries can run to the same time range that you used to limit his row retrieval.

When you create a named time range, Adaptive Server stores it in the *systimeranges* system table to control when a resource limit is active. Each time range has a range ID number. The "at all times" range is range ID 1. Adaptive Server messages refer to specific time ranges.

Determining the Time Ranges You Need

Use a chart like the one below to determine the time ranges to create for each server. Monitor server usage throughout the week; then indicate the periods when your server is especially busy or is performing crucial tasks that should not be interrupted.

Day / Time	00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	00:00
Mon																									
Tues																									
Wed																									
Thurs																									
Fri																									
Sat																									
Sun																									

Creating Named Time Ranges

Create new time ranges use **sp_add_time_range** to:

- Name the time range
- Specify the days of the week to begin and end the time range

- Specify the times of the day to begin and end the time range

For syntax and detailed information, see **sp_add_time_range** in the *Adaptive Server Reference Manual*.

A Time Range Example

Assume that two critical jobs are scheduled to run every week at the following times.

- Job 1 runs from 07:00 to 10:00 on Tuesday and Wednesday.
- Job 2 runs from 08:00 on Saturday to 13:00 on Sunday.

The following table uses "1" to indicate when job 1 runs and "2" to indicate when job 2 runs:.

Day / Time	00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	00:00
Mon																									
Tues								1	1	1	1														
Wed								1	1	1	1														
Thurs																									
Fri																									
Sat									2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Sun	2	2	2	2	2	2	2	2	2	2	2	2	2	2											

Job 1 can be covered by a single time range, *tu_wed_7_10*:

```
sp_add_time_range tu_wed_7_10, tuesday, wednesday,
"7:00", "10:00"
```

Job 2, however, requires two separate time ranges, for Saturday and Sunday:

```
sp_add_time_range saturday_night, saturday,
saturday, "08:00", "23:59"

sp_add_time_range sunday_morning, sunday, sunday,
"00:00", "13:00"
```

Modifying a Named Time Range

Use **sp_modify_time_range** to:

- Specify which time range to modify
- Specify the change to the days of the week
- Specify the change to the times of the day

For syntax and detailed information, see **sp_modify_time_range** in the *Adaptive Server Reference Manual*.

For example, to change the end day of the *business_hours* time range to Saturday, retaining the existing start day, start time, and end time, enter:

```
sp_modify_time_range business_hours, NULL,
Saturday, NULL, NULL
```

To specify a new end day and end time for the *before_hours* time range, enter:

```
sp_modify_time_range before_hours, NULL, Saturday,
NULL, "08:00"
```

➤ ***Note***

You cannot modify the “at all times” time range.

Dropping a Named Time Range

Use **sp_drop_time_range** to drop a user-defined time range

For syntax and detailed information, see **sp_drop_time_range** in the *Adaptive Server Reference Manual*.

For example, to remove the *evenings* time range from the *systimeranges* system table in the *master* database, enter:

```
sp_drop_time_range evenings
```

➤ ***Note***

You cannot drop the “at all times” time range or any time range for which resource limits are defined.

When Do Time Range Changes Take Effect?

The active time ranges are bound to a login session at the beginning of each query batch. A change in the server's active time ranges due to a change in actual time has no effect on a session during the processing of a query batch. In other words, if a resource limit restricts query batches during a given time range, but the query batch begins before that time range becomes active, the query batch that is already running is not affected by the resource limit. However, if you run a second query batch during the same login session, that query batch will be affected by the change in time.

Adding, modifying, and deleting time ranges does not affect the active time ranges for the login sessions currently in progress.

If a resource limit has a transaction as its scope, and a change occurs in the server's active time ranges while a transaction is running, the newly active time range does not affect the transaction currently in progress.

Identifying Users and Limits

For each resource limit, you must specify the object to which the limit applies.

You can apply a resource limit to any of the following:

- All applications used by a particular login
- All logins that use a particular application
- A specific application used by a particular login

where **application** is defined as a client program running on top of Adaptive Server, accessed through a particular login. To run an application on Adaptive Server, you must specify its name through the CS_APPNAME connection property using **cs_config** (an Open Client Client-Library application) or the DBSETLAPP function in Open Client DB-Library. To list named applications running on your server, select the *program_name* column from the *master..sysprocesses* table.

For more information about the CS_APPNAME connection property, see the *Open Client Client-Library/C Reference Manual*. For more information on the DBSETLAPP function, see the *Open Client DB-Library/C Reference Manual*.

Identifying Heavy-Usage Users

Before you implement resource limits, run **sp_reportstats**. The output from this procedure will help you identify the users with heavy system usage. For example:

```
sp_reportstats
```

```
Name    Since          CPU     Percent CPU  I/O     Percent I/O
------  -----------    -----   ------------ -----   -------------
probe   jun 19 1993    0       0%           0       0%
julie   jun 19 1993    10000   24.9962%     5000    24.325%
jason   jun 19 1993    10002   25.0013%     5321    25.8866%
ken     jun 19 1993    10001   24.9987%     5123    24.9234%
kathy   jun 19 1993    10003   25.0038%     5111    24.865%

      Total CPU   Total I/O
      ---------   ---------
      40006       20555
```

The output above indicates that usage is balanced among the users. For more information on chargeback accounting, see “cpu accounting flush interval” on page 17-119 and “i/o accounting flush interval” on page 17-131.

Identifying Heavy-Usage Applications

To identify the applications running on your system and the users who are running them, query the *sysprocesses* system table in the *master* database.

The following query determines that **isql**, **payroll**, **perl**, and **acctng** are the only client programs whose names were passed to the Adaptive Server:

```
select spid, cpu, physical_io,
  substring(user_name(uid),1,10) user_name,
  hostname, program_name, cmd
from sysprocesses
```

```
spid  cpu    physical_io  user_name hostname program_name cmd
----  ---    -----------  --------- -------- ------------ ------
  17    4          12748  dbo       sabrina  isql         SELECT
 424    5              0  dbo       HOWELL   isql         UPDATE
 526    0            365  joe       scotty   payroll      UPDATE
 568    1           8160  dbo       smokey   perl         SELECT
 595   10              1  dbo       froth    isql         DELETE
 646    1              0  guest     walker   isql         SELECT
 775    4          48723  joe_user  mohindra acctng       SELECT

(7 rows affected)
```

Because *sysprocesses* is built dynamically to report current processes, repeated queries produce different results. Repeat this query throughout the day over a period of time to determine which applications are running on your system.

The CPU and physical I/O values are flushed to the *syslogins* system table periodically where they increment the values shown by **sp_reportstats**.

After identifying the applications running on your system, use **showplan** and **statistics io** to evaluate the resource usage of the queries in the applications.

If you have configured Adaptive Server to enable resource limits, you can use **showplan** to evaluate resources used prior to execution and **statistics io** to evaluate resources used during execution. For information on configuring Adaptive Server to enable resource limits, see "Enabling Resource Limits" on page 18-2.

In addition to **statistics io**, **statistics time** is also useful for evaluating the resources a query consumes. Use **statistics time** to display the time it takes to execute each step of the query. For more information, see "Diagnostic Tools for Query Optimization" on page 12-6 in the *Performance and Tuning Guide*.

Choosing a Limit Type

After you determine the users and applications to limit, you have a choice of three different types of resource limits.

Table 18-1 describes the function and scope of each limit type and indicates the tools that help determine whether a particular query might benefit from this type of limit. In some cases, it may be appropriate to create more than one type of limit for a given user and

application. For more information on limit types, see "Understanding Limit Types" on page 18-12.

Table 18-1: Resource limit types

Limit Type	Use for Queries That	Measuring Resource Usage	Scope	Enforced During
io_cost	Require many logical and physical reads	Use **set showplan on** before running the query, to display its estimated I/O cost; use **set statistics io on** to observe the actual I/O cost.	Query	Pre-execution or execution
row_count	Return large result sets	Use the *@@rowcount* global variable to help develop appropriate limits for row count.	Query	Execution
elapsed_time	Take a long time to complete, either because of their own complexity or because of external factors such as server load or waiting for a lock	Use **set statistics time on** before running the query, to display elapsed time in milliseconds.	Query batch or transaction	Execution

The *spt_limit_types* system table stores information about each limit type.

Determining Time of Enforcement

Time of enforcement is the phase of query processing during which Adaptive Server applies a given resource limit. Resource limits occur during:

- Pre-execution – Adaptive Server applies resource limits prior to execution, based on the optimizer's I/O cost estimate. This limit prevents execution of potentially expensive queries. I/O cost is the only resource type that can be limited at pre-execution time.

  When evaluating the I/O cost of data manipulation language (DML) statements within the clauses of a conditional statement, Adaptive Server considers each DML statement individually. It evaluates all statements, even though only one clause will actually be executed.

  A pre-execution time resource limit can have only a query limit scope; that is, the values of the resources being limited at

compile time are computed and monitored on a query-by-query basis only.

Adaptive Server does not enforce pre-execution time resource limits statements in a trigger.

- Execution – Adaptive Server applies resource limits at runtime, and is usually used to prevent a query from monopolizing server and operating system resources. Execution time limits may use more resources (additional CPU time as well as I/O) than pre-execution time limits.

Determining the Scope of Resource Limits

The *scope* parameter specifies the duration of a limit in Transact-SQL statements. The possible limit scopes are query, query batch, and transaction:

- Query – Adaptive Server applies resource limits to any single Transact-SQL statement that accesses the server; for example, **select**, **insert**, and **update**. When you issue these statements within a query batch, Adaptive Server evaluates them individually.

  Adaptive Server considers a stored procedure to be a series of DML statements. It evaluates the resource limit of each statement within the stored procedure. If a stored procedure executes another stored procedure, Adaptive Server evaluates each DML statement within the nested stored procedure at the inner nesting level.

  Adaptive Server checks pre-execution time resource limits with a query scope, one nesting level at a time. As Adaptive Server enters each nesting level, it checks the active resource limits against the estimated resource usage of each DML statement prior to executing any of the statements at that nesting level. A resource limit violation occurs if the estimated resource usage of any DML query at that nesting level exceeds the limit value of an active resource limit. Adaptive Server takes the action that is bound to the violated resource limit.

  Adaptive Server checks execution time resource limits with a query scope against the cumulative resource usage of each DML query. A limit violation occurs when the resource usage of a query exceeds the limit value of an active execution time resource limit. Again, Adaptive Server takes the action that is bound to that resource limit.

- Query batch – query batch consists of one or more Transact-SQL statements; for example, in **isql**, a group of queries becomes a query batch when executed by a single **go** command terminator.

  The query batch begins at nesting level 0; each call to a stored procedure increments the nesting level by 1 (up to the maximum nesting level). Each return from a stored procedure decrements the nesting level by 1.

  Only execution time resource limits can have a query batch scope.

  Adaptive Server checks execution time resource limits with a query batch scope against the cumulative resource usage of the statements in each query batch. A limit violation occurs when the resource usage of the query batch exceeds the limit value of an active execution time resource limit. Adaptive Server takes the action that is bound to that resource limit.
- Transaction – Adaptive Server applies limits with a transaction scope to all nesting levels during the transaction against the cumulative resource usage for the transaction.

  A limit violation occurs when the resource usage of the transaction exceeds the limit value of an active execution time resource limit. Adaptive Server takes the action that is bound to that resource limit.

  Only execution time resource limits can have a transaction scope.

  Adaptive Server does not recognize nested transactions when applying resource limits. A resource limit on a transaction begins when *@@trancount* is set to 1 and ends when *@@trancount* is set to 0.

Understanding Limit Types

There are three types of resource limits that allow you to limit resource usage in different ways.

Limiting I/O Cost

I/O cost is based on the number of logical and physical accesses ("reads") used during query processing. To determine the most efficient processing plan prior to execution, the Adaptive Server

optimizer uses both logical and physical resources to compute an estimated I/O cost.

Adaptive Server uses the result of the optimizer's costing formula as a "unitless" number; that is, a value not necessarily based on a single unit of measurement (such as seconds or milliseconds).

To set resource limits, you must understand how those limits translate into runtime system overhead. For example, you must know the effect that a query with a cost of *x* logical and of *y* physical I/Os has on a production server.

Limiting **io_cost** can control I/O intensive queries, including queries that return a large result set. However, if you run a simple query that returns all the rows of a large table, and you do not have current statistics on the table's size, the optimizer may not estimate that the query will exceed the **io_cost** resource limit. To prevent queries from returning large result sets, create a resource limit on **row_count**.

The tracking of I/O cost limits may be less precise for partitioned tables than for unpartitioned tables when Adaptive Server is configured for parallel query processing. For more information on using resource limits in parallel queries, see the *Performance and Tuning Guide*.

Identifying I/O Costs

To develop appropriate limits for I/O cost, determine the number of logical and physical reads required for some typical queries. Use the following **set** commands:

- **set showplan on** displays the optimizer's cost estimate. Use this information to set pre-execution time resource limits. A pre-execution time resource limit violation occurs when the optimizer's I/O cost estimate for a query exceeds the limit value. Such limits prevent the execution of potentially expensive queries.
- **set statistics io on** displays the number of actual logical and physical reads required. Use this information to set execution time resource limits. An execution time resource limit violation occurs when the actual I/O cost for a query exceeds the limit value.

Statistics for actual I/O cost include access costs only for user tables and worktables involved in the query. Adaptive Server may use other tables internally; for example, it accesses *sysmessages* to print out statistics. Therefore, there may be instances when a query

exceeds its actual I/O cost limit, even though the statistics indicate otherwise.

In costing a query, the optimizer assumes that every page needed will require a physical I/O for the first access and will be found in the cache for repeated accesses. Actual I/O costs may differ from the optimizer's estimated costs, for several reasons.

The estimated cost will be higher than the actual cost if some pages are already in the cache or if the statistics are incorrect. The estimated cost may be lower than the actual cost if the optimizer chooses 16K I/O, and some of the pages are in 2K cache pools, which requires many 2K I/Os. Also, if a big join forces the cache to flush its pages back to disk, repeated access may require repeated physical I/Os.

The optimizer's estimates will not be accurate if the distribution or density statistics are out of date or cannot be used.

Calculating the I/O Cost of a Cursor

The cost estimate for processing a cursor is calculated at **declare cursor** time for all cursors except execute cursors, which is calculated when the cursor opens.

Pre-execution time resource limits on I/O cost are enforced at **open** *cursorname* time for all cursor types. The optimizer recalculates the limit value each time the user attempts to open the cursor.

An execution time resource limit applies to the cumulative I/O cost of a cursor from the time the cursor opens to the time it closes. The optimizer recalculates the I/O limit each time a cursor opens.

For a discussion of cursors, see Chapter 17, "Cursors: Accessing Data Row by Row," in the *Transact-SQL User's Guide*.

The Scope of the *io_cost* Limit Type

A resource limit that restricts I/O cost applies only to single queries. If you issue several statements in a query batch, Adaptive Server evaluates the I/O usage for each query. For more information, see "Determining the Scope of Resource Limits" on page 18-11.

Limiting Elapsed Time

Elapsed time is the number of seconds, in wall-clock time, required to execute a query batch or transaction. Elapsed time is determined

by such factors as query complexity, server load, and waiting for locks.

To help develop appropriate limits for elapsed time use information you have gathered with **set statistics time** You can limit the elapsed time resource only at execution time.

With **set statistics time** set **on**, run some typical queries to determine processing time in milliseconds. Convert milliseconds to seconds when you create the resource limit.

Elapsed time resource limits are applied to all SQL statements in the limit's scope (query batch or transaction), not just to the DML statements. A resource limit violation occurs when the elapsed time for the appropriate scope exceeds the limit value.

Because elapsed time is limited only at execution time, an individual query will continue to run, even if its elapsed time exceeds the limit. If there are multiple statements in a batch, an elapsed time limit takes effect after a statement violates the limit and before the next statement is executed. If there is only one statement in a batch, setting an elapsed time limit has no effect.

Separate elapsed time limits are not applied to nested stored procedures or transactions. In other words, if one transaction is nested within another, the elapsed time limit applies to the outer transaction, which encompasses the elapsed time of the inner transaction. Therefore, if you are counting the wall-clock running time of a transaction, that running time includes all nested transactions.

The Scope of the *elapsed_time* Limit Type

The scope of a resource limit that restricts elapsed time is either a query batch or transaction. You cannot restrict the elapsed time of a single query. For more information, see "Determining the Scope of Resource Limits" on page 18-11.

Limiting the Size of the Result Set

The **row_count** limit type limits the number of rows returned to the user. A limit violation occurs when the number of rows returned by a **select** statement exceeds the limit value.

If the resource limit issues a warning as its action, and a query exceeds the row limit, the full number of rows are returned, followed by a warning that indicates the limit value; for example:

```
Row count exceeded limit of 50.
```

If the resource limit's action aborts the query batch or transaction or kills the session, and a query exceeds the row limit, only the limited number of rows are returned and the query batch, transaction, or session aborts. Adaptive Server displays a message like the following:

```
Row count exceeded limit of 50.
Transaction has been aborted.
```

The **row_count** limit type applies to all **select** statements at execution time. You cannot limit an estimated number of rows returned at pre-execution time.

Determining Row Count Limits

Use the *@@rowcount* global variable to help develop appropriate limits for row count. Selecting this variable after running a typical query can tell you how many rows the query returned.

Applying Row Count Limits to a Cursor

A row count limit applies to the cumulative number of rows that are returned through a cursor from the time the cursor opens to the time it closes. The optimizer recalculates the **row_count** limit each time a cursor opens.

The Scope of the *row_count* Limit Type

A resource limit that restricts row count applies only to single queries, not to cumulative rows returned by a query batch or transaction. For more information, see "Determining the Scope of Resource Limits" on page 18-11.

Creating a Resource Limit

Create a new resource limit with **sp_add_resource_limit**. The syntax is:

```
sp_add_resource_limit name, appname, rangename,
   limittype, limit_value, enforced, action, scope
```

Use this system procedure's parameters to:

- Specify the name of the user or application to which the resource limit applies.

You must specify either a *name* or an *appname* or both. If you specify a user, the name must exist in the *syslogins* table. Specify "null" to create a limit that applies to all users or all applications.

- Specify the time range.

  The time range must already exist when you create the limit. For more information, see "Defining Time Ranges" on page 18-3.

- Specify the type of limit (**io_cost**, **row_count**, or **elapsed_time**), and set an appropriate value for the limit type.

  For more information, see "Choosing a Limit Type" on page 18-9.

- Specify whether the resource limit is enforced prior to or during query execution.

  Specify numeric values for this parameter. Pre-execution time resource limits, which are specified as 1, are valid only for the **io_cost** limit. Execution time resource limits, which are specified as 2, are valid for all three limit types. For more information, see "Determining Time of Enforcement" on page 18-10.

- Specify the action to be taken (issue a warning, abort the query batch, abort the transaction, or kill the session).

  Specify numeric values for this parameter.

- Specify the scope (query, query batch, or transaction).

  Specify numeric values for this parameter. For more information, see "Determining the Scope of Resource Limits" on page 18-11.

For detailed information, see **sp_add_resource_limit** in the *Adaptive Server Reference Manual*.

Resource Limit Examples

This section includes three examples of setting resource limits.

Example 1

```
sp_add_resource_limit NULL, payroll, tu_wed_7_10,
elapsed_time, 120, 2, 1, 2
```

This example creates a resource limit that applies to all users of the **payroll** application because the name parameter is NULL. The limit is valid during the *tu_wed_7_10* time range. The limit type, **elapsed_time**,

is set to a value of 120 seconds. Because **elapsed_time** is enforced only at execution time, the *enforced* parameter is set to 2. The *action* parameter is set to 1, which issues a warning. The limit's *scope* is set to 2, query batch, by the last parameter. Therefore, when the elapsed time of the query batch takes more than 120 seconds to execute, Adaptive Server issues a warning.

Example 2

```
sp_add_resource_limit joe_user, NULL,
saturday_night, row_count, 5000, 2, 3, 1
```

This example creates a resource limit that applies to all ad hoc queries and applications run by "joe_user" during the *saturday_night* time range. If a query (*scope* = 1) returns more than 5000 rows, Adaptive Server aborts the transaction (*action* = 3). This resource limit is enforced at execution time (*enforced* = 2).

Example 3

```
sp_add_resource_limit joe_user, NULL, "at all
times", io_cost, 650, 1, 3, 1
```

This example also creates a resource limit that applies to all ad hoc queries and applications run by "joe_user." However, this resource limit specifies the default time range, "at all times." When the optimizer estimates that the **io_cost** of the query (*scope* = 1) would exceed the specified value of 650, Adaptive Server aborts the transaction (*action* = 3). This resource limit is enforced at pre-execution time (*enforced* = 1).

Getting Information on Existing Limits

Use **sp_help_resource_limit** to get information about existing resource limits.

Users who do not have the System Administrator role can use **sp_help_resource_limit** to list their own resource limits (only).

Users either specify their own login names as a parameter or specify the *name* parameter as "null." The following examples return all resource limits for user "joe_user" when executed by joe_user:

```
sp_help_resource_limit
```

or

```
sp_help_resource_limit joe_user
```

System Administrators can use **sp_help_resource_limit** to get the following information:

- All limits as stored in *sysresourcelimits* (all parameters NULL); for example:

  ```
  sp_help_resource_limit
  ```

- All limits for a given login (*name* is not NULL, all other parameters are NULL); for example:

  ```
  sp_help_resource_limit joe_user
  ```

- All limits for a given application (*appname* is not NULL; all other parameters are NULL); for example:

  ```
  sp_help_resource_limit NULL, payroll
  ```

- All limits in effect at a given time or day (either *limittime* or *limitday* is not NULL; all other parameters NULL); for example:

  ```
  sp_help_resource_limit @limitday = wednesday
  ```

- Limit, if any, in effect at a given time for a given login (*name* is not NULL, either *limittime* or *limitday* is not NULL); for example:

  ```
  sp_help_resource_limit joe_user, NULL, NULL,
  wednesday
  ```

For detailed information, see **sp_help_resource_limit** in the *Adaptive Server Reference Manual*.

Example of Listing All Existing Resource Limits

When you use **sp_help_resource_limit** without any parameters, Adaptive Server lists all resource limits within the server. For example:

```
sp_help_resource_limit
```

```
name      appname rangename rangeid limitid limitvalue enforced  action scope
----      ------- --------- ------- ------- ---------- --------  ------ -----
NULL      acctng  evenings        4       2        120         2       1     2
stein     NULL    weekends        1       3       5000         2       1     1
joe_user  acctng  bus_hours       5       3       2500         2       2     1
joe_user  finance bus_hours       5       2        160         2       1     6
wong      NULL    mornings        2       3       2000         2       1     1
wong      acctng  bus_hours       5       1         75         1       3     1
```

In the output, the *rangeid* column prints the value from *systimeranges.id* that corresponds to the name in the *rangename* column. The *limitvalue* column reports the value set by **sp_add_resource_limit** or **sp_modify_resource_limit**. Table 18-2 shows the

meaning of the values in the *limitid*, *enforced*, *action*, and *scope* columns.

Table 18-2: Values for *sp_help_resource_limit* output

Column	Meaning	Value
limitid	What kind of limit is it?	1 I/O cost 2 Elapsed time 3 Row count
enforced	When is the limit enforced?	1 reexecution 2 During execution 3 Both
action	What action is taken when the limit is hit?	1 Issue a warning 2 Abort the query batch 3 Abort the transaction 4 Kill the session
scope	What is the scope of the limit?	1 Query 2 Query batch 4 Transaction 6 Query batch + transaction

If a System Administrator specifies a login name when executing **sp_help_resource_limit**, Adaptive Server lists all resource limits for that login. The output displays not only resource limits specific to the named user, but all resource limits that pertain to all users of specified applications, because the named user is included among all users.

For example, the following output shows all resource limits that apply to "joe_user". Because a resource limit is defined for all users of the **acctng** application, this limit is included in the output.

```
sp_help_resource_limit joe_user
```

```
name     appname rangename rangeid limitid limitvalue enforced  action scope
----     ------- --------- ------- ------- ---------- --------  ------ -----
NULL     acctng  evenings        4       2        120         2       1     2
joe_user acctng  bus_hours       5       3       2500         2       2     1
joe_user finance bus_hours       5       2        160         2       1     6
```

Modifying Resource Limits

Use **sp_modify_resource_limit** to specify a new limit value or a new action to take when the limit is exceeded or both. You cannot change the

login or application to which a limit applies or specify a new time range, limit type, enforcement time, or scope.

The syntax of **sp_modify_resource_limit** is:

```
sp_modify_resource_limit name, appname, rangename,
   limittype, limitvalue, enforced, action, scope
```

To modify a resource limit, specify the following values:

- You must specify a non-null value for either *name* or *appname*.
  - To modify a limit that applies to all users of a particular application, specify a *name* of "null."
  - To modify a limit that applies to all applications used by *name*, specify an *appnam*e of "null."
  - To modify a limit that governs a particular application, specify the application name that the client program passes to the Adaptive Server in the login packet.
- You must specify non-null values for *rangename* and *limittype*. If necessary to uniquely identify the limit, specify non-null values for *action* and *scope*.
- Specifying "null" for *limitvalue* or *action* indicates that its value does not change.

For detailed information, see **sp_modify_resource_limit** in the *Adaptive Server Reference Manual*.

Examples of Modifying a Resource Limit

```
sp_modify_resource_limit NULL, payroll,
tu_wed_7_10, elapsed_time, 90, null, null, 2
```

This example changes the value of the resource limit that restricts elapsed time to all users of the *payroll* application during the *tu_wed_7_10* time range. The limit value for elapsed time decreases to 90 seconds (from 120 seconds). The values for time of execution, action taken, and scope remain unchanged.

```
sp_modify_resource_limit joe_user, NULL,
saturday_night, row_count, NULL, NULL, 2, NULL
```

This example changes the action taken by the resource limit that restricts the row count of all ad hoc queries and applications run by "joe_user" during the *saturday_night* time range. The previous value for action was 3, which aborts the transaction when a query exceeds the specified row count. The new value is to 2, which aborts the

query batch. The values for limit type, time of execution, and scope remain unchanged.

Dropping Resource Limits

Use **sp_drop_resource_limit** to drop a resource limit from an Adaptive Server.

The syntax is:

```
sp_drop_resource_limit {name , appname } [,
   rangename, limittype, enforced, action, scope]
```

Specify enough information to uniquely identify the limit. You must specify a non-null value for either *name* or *appname*. In addition, specify values according to those shown in Table 18-3.

Table 18-3: Identifying resource limits to drop

Parameter	Value Specified	Consequence
name	• Specified login	Drops limits that apply to the particular login.
	• NULL	Drops limits that apply to all users of a particular application.
appname	• Specified application	Drops limits that apply to a particular application.
	• NULL	Drops limits that apply to all applications used by the specified login.
timerange	• An existing time range stored in the *systimeranges* system table	Drops limits that apply to a particular time range.
	• NULL	Drops all resource limits for the specified *name*, *appname*, *limittype*, enforcement time, *action*, and *scope*, without regard to *rangename*.
limittype	• One of the three limit types: **row_count**, **elapsed_time**, **io_cost**	Drops limits that apply to a particular limit type.
	• NULL	Drops all resource limits for the specified *name*, *appname*, *timerange*, *action*, and *scope*, without regard to *limittype*.
enforced	• One of the enforcement times: pre-execution or execution	Drops the limits that apply to the specified enforcement time.
	• NULL	Drops all resource limits for the specified *name*, *appname*, *limittype*, *timerange*, *action*, and *scope*, without regard to enforcement time.

Table 18-3: Identifying resource limits to drop (continued)

Parameter	Value Specified	Consequence
action	• One of the four action types: issue warning, abort query batch, abort transaction, kill session	Drops the limits that apply to a particular action type.
	• NULL	Drops all resource limits for the specified *name*, *appname*, *timerange*, *limittype*, enforcement time, and *scope*, without regard to *action*.
scope	• One of the scope types: query, query batch, transaction	Drops the limits that apply to a particular scope.
	• NULL	Drops all resource limits for the specified *name*, *appname*, *timerange*, *limittype*, enforcement time, and *action*, without regard to *scope*.

When you use **sp_droplogin** to drop an Adaptive Server login, all resource limits associated with that login are also dropped.

For detailed information, see **sp_drop_resource_limit** in the *Adaptive Server Reference Manual*.

Examples of Dropping a Resource Limit

```
sp_drop_resource_limit NULL, payroll, tu_wed_7_10
```

This example drops all resource limits for all users of the payroll application during the *tu_wed_7_10* time range.

```
sp_drop_resource_limit NULL, payroll, tu_wed_7_10,
elapsed_time
```

This example is similar to the preceding example, but drops only the resource limit that governs elapsed time for all users of the payroll application during the *tu_wed_7_10* time range.

```
sp_drop_resource_limit joe_user
```

This example drops all resource limits for “joe_user.”

Resource Limit Precedence

Adaptive Server provides precedence rules for time ranges and resource limits.

Time Ranges

For each login session during the currently active time ranges, only one limit can be active for each distinct combination of limit type, enforcement time, and scope. The precedence rules for determining the active limit are as follows:

- If no limit is defined for the login ID for either the "at all times" range or the currently active time ranges, there is no active limit.
- If limits are defined for the login for both the "at all times" and time-specific ranges, then the limit for the time-specific range takes precedence.

Resource Limits

Since either the user's login name or the application name, or both, are used to identify a resource limit, Adaptive Server observes a predefined search precedence while scanning the *sysresourcelimits* table for applicable limits for a login session. The following table describes the precedence of matching ordered pairs of login name and application name:

Level	Login Name	Application Name
1	joe_user	**payroll**
2	NULL	**payroll**
3	joe_user	NULL

If one or more matches are found for a given precedence level, no further levels are searched. This prevents conflicts regarding similar limits for different login / application combinations.

If no match is found at any level, no limit is imposed on the session.

19 Configuring Character Sets, Sort Orders, and Languages

This chapter discusses Adaptive Server internationalization and localization support issues. Topics include:

Language Support for International Installations

Sybase provides both internationalization and localization support. **Internationalization** is the process of designing software products so that a single version can be adapted to different languages or regions, conforming to local requirements and customs without engineering changes. Adaptive Server can process the characters used in different languages. ASE includes the character set definition files and sort order definition files required for data processing support for the major business languages in Western Europe, Eastern Europe, the Middle East, Latin America, and Asia.

Localization is the adaptation of an internationalized product to meet the requirements of one particular language or region, including translated system messages and correct formats for date, time, and currency. Sybase Language Modules provide translated system messages and formats for: Chinese (Simplified), French, German, Japanese, Korean, Brazilian Portuguese, and Spanish. By default, Adaptive Server comes with U.S. English message files.

This chapter describes the character sets and language modules and summarizes the steps needed to change the default character set, sort order, or message language for Adaptive Server.

Character Sets and Sort Orders

Character Set Support

A **character set** is a specific collection of characters (including alphabetic and numeric characters, symbols, and nonprinting control characters) and their assigned numerical values. A character set generally contains the characters for an alphabet, for example, the Latin alphabet used in the English language, or a script such as Cyrillic used with languages such as Russian, Serbian, and Bulgarian. Character sets that are platform-specific and support a subset of languages, for example, the Western European languages, are called **native character sets**. All character sets that come with Adaptive Server, except for Unicode UTF-8, are native character sets.

A **script** is a writing system, a collection of all the elements that characterize the written form of a human language—for example, Latin, Japanese, and Arabic. Depending on the languages supported by an alphabet or script, a character set can support one or more languages (in addition to English). The language or languages that are covered by a character set is called a **language group**.

Unlike the native character sets, Unicode is an international character set and supports over 650 of the world's languages, such as Japanese, Chinese, Russian, French, and German. Unicode allows you to mix different languages from different language groups in the same server.

Adaptive Server supports the following languages and character sets.

Table 19-1: Supported languages and character sets

Language Group	Languages	Character Sets
Group 1	**Western European:** Albanian, Catalan, Danish, Dutch, English, Faeroese, Finnish, French, Galician, German, Icelandic, Irish, Italian, Norwegian, Portuguese, Spanish, Swedish	ASCII 8, CP 437, CP 850, CP 860, CP 863, CP 1252[a], ISO 8859-1, ISO 8859-15, Macintosh Roman, ROMAN8

Table 19-1: Supported languages and character sets (continued)

Language Group	Languages	Character Sets
Group 2	**Eastern European:** Croatian, Czech, Estonian, Hungarian, Latvian, Lithuanian, Polish, Romanian, Slovak, Slovene	CP 852, CP 1250, ISO 8859-2, Macintosh Central European
Group 4	Baltic	CP 1257
Group 5	**Cyrillic:** Bulgarian, Byelorussian, Macedonian, Russian, Serbian, Ukrainian	CP 855, CP 866, CP 1251, ISO 8859-5, Koi8, Macintosh Cyrillic
Group 6	Arabic	CP 864, CP 1256, ISO 8859-6
Group 7	Greek	CP 869, CP 1253, GREEK8, ISO 8859-7, Macintosh Greek
Group 8	Hebrew	CP 1255, ISO 8859-8
Group 9	Turkish	CP 857, CP 1254, ISO 8859-9, Macintosh Turkish, TURKISH8
Group 101	Japanese	CP 932[b], DEC Kanji, EUC-JIS, Shift-JIS
Group 102	Simplified Chinese (PRC)	CP 936, EUC-GB
Group 103	Traditional Chinese (ROC)	Big 5, CP 950[c], EUC-CNS
Group 104	Korean	EUC-KSC
Group 105	Thai	CP 874, TIS 620
Group 106	Vietnamese	CP 1258
Unicode	Over 650 languages	UTF-8

a. CP 1252 is identical to ISO 8859-1 except for the 0x80–0x9F codepoints which are mapped to different characters in CP 1252 and ISO 8859-1.

b. CP 932 is identical to Shift-JIS.

c. CP 950 is identical to Big 5.

English is included in all language groups. All character sets support English because the first 128 codepoints of any character set include the Latin alphabet. The characters beyond the first 128 differ between character sets and are used to support the characters in different languages.

The following character sets support the European currency symbol, the "euro":

- CP 1252 (Western Europe)
- CP 1250 (Eastern Europe)
- CP 1251 (Cyrillic)
- CP 1256 (Arabic)
- CP 1253 (Greek)
- CP 1255 (Hebrew)
- CP 1254 (Turkish)
- CP 874 (Thai)

Here is the symbol for the euro:

Types of Internationalization Files

The files that support data processing in a particular language are called **internationalization files**. Several types of internationalization files come with Adaptive Server. Table 19-2 describes these files.

Table 19-2: Internationalization files

File	Location	Purpose and Contents
charset.loc	In each character set subdirectory of the *charsets* directory	Character set definition files that define the lexical properties of each character, such as alphanumeric, punctuation, operand, and uppercase or lowercase. Used by Adaptive Server to correctly process data.
**.srt*	In each character set subdirectory of the *charsets* directory	Defines the sort order for alphanumeric and special characters, including ligatures, diacritics, and other language-specific considerations.

Table 19-2: Internationalization files

File	Location	Purpose and Contents
**.xlt*	In each character set subdirectory of the *charsets* directory	Terminal-specific character translation files for use with utilities such as **bcp** and **isql**. For more information about how the *.xlt* files are used, see Chapter 20, "Configuring Client/Server Character Set Conversions," and the *Utility Programs* manual for your platform.

◆ ***WARNING!***

Do not alter any of the internationalization files. If you need to install a new terminal definition or sort order, contact your local Sybase distributor.

Character Sets Directory Structure

The following diagram shows the directory structure for the Western European character sets that come with Adaptive Server. There is a separate subdirectory for each character set in the *charsets* directory. Within the subdirectory for each character set (for example, *cp850*) are the character set and sort order definition files and terminal-specific files.

If you load additional character sets, they will also appear in the *charsets* directory:

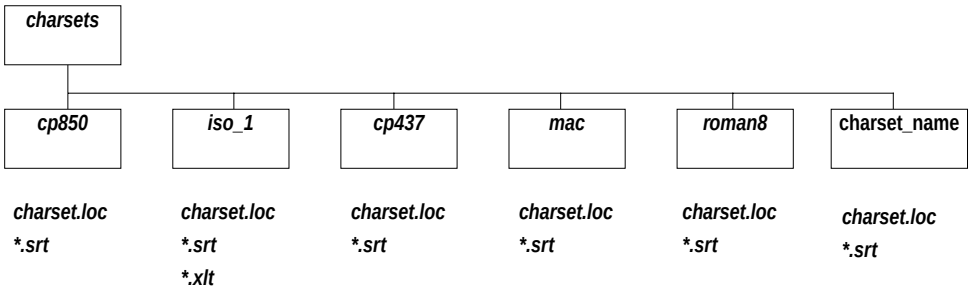


Figure 19-1: Structure of the *charsets* directory

The following global variables contain information about character set:

@@char_convert	Contains 0 if character set conversion is not in effect. Contains 1 if character set conversion is in effect.
@@client_csname	The client's character set name. Set to NULL if client character set has never been initialized; otherwise, it contains the name of the most recently used character set.
@@client_csid	The client's character set ID. Set to -1 if client character set has never been initialized; otherwise, it contains the most recently used client character set ID from *syscharsets*.
@@maxcharlen	The maximum length, in bytes, of a character in Adaptive Server's default character set.
@@ncharsize	The average length, in bytes, of a national character.

Software Messages

International installations of Adaptive Server are supported with Language Modules containing files of translated software messages and language or locale formats. Adaptive Server provides language modules in the following languages: Chinese (Simplified), French, German, Japanese, Korean, Brazilian Portuguese, and Spanish.

These files, located in the *locales* subdirectory of the Adaptive Server installation directory, are called **localization files**.

Types of Localization Files

Several localization files are supplied for each language module, as shown in Table 19-3.

Table 19-3: Localization files

File	Location	Purpose and Contents
locales.dat	In the *locales* directory	Used by client applications to identify the default message language and character set.
server.loc	In the character set subdirectories under each language subdirectory in the *locales* directory	Software messages translated into the local language. Sybase products have product-specific *.*loc* files. If an entry is not translated, that software message or string appears in U.S. English instead of the local language.
common.loc	In each language and character set directory of the *locales* directory	Contains the local names of the months of the year and their abbreviations and information about the local date, time, and money formats.

◆ ***WARNING!***

Do not alter any of the localization files. If you need to alter any information in those files, contact your local Sybase distributor.

Software Messages Directory Structure

Figure 19-2 shows how localization files are arranged. Within the *locales* directory is a subdirectory for each language installed. There is always a *us_english* subdirectory. (On PC platforms, this directory is called *english*.) During installation, when you are prompted to select the languages you want installed on Adaptive Server, the install program lists the supported software message languages. If you install language modules for additional languages, you will see subdirectories for those languages. Within each language are

subdirectories for the supported character sets; for example, *cp850* is a supported character set for *us_english*. Software message files for each Sybase product reside in the subdirectory for each character set.

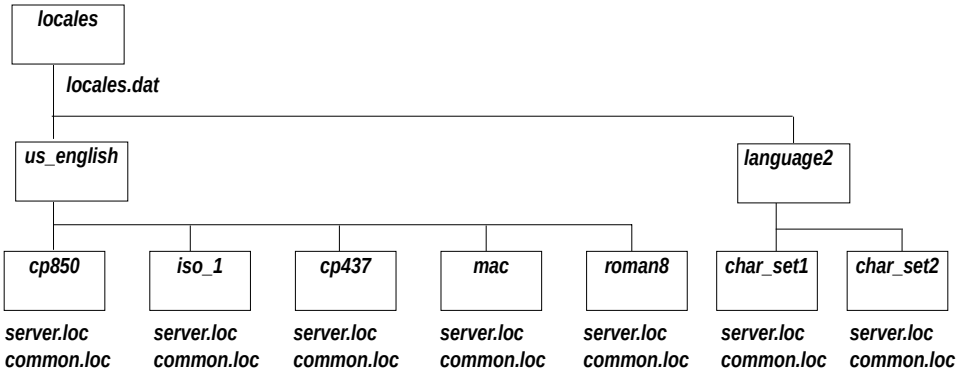


Figure 19-2: Messages directory structure

Message Languages and Global Variables

The following global variables contain information about languages:

@@langid	Contains the local language ID of the language currently in use (specified in *syslanguages.langid*).
@@language	Contains the name of the language currently in use (specified in *syslanguages.name*).

Disabling Character Set Conversion Between Adaptive Server and Clients

If a client uses a different character set than the one used by Adaptive Server, Adaptive Server's default is to convert the data to the server's character set when data is inserted or loaded and to convert back to the client's character set when data is returned to the user. This behavior supports users of many different systems in a heterogeneous environment; however, in some cases, no conversion is needed.

For example, if some clients use Latin 1 (iso_1) and Adaptive Server uses ROMAN8 (roman8) as its default character set, data from the

clients is converted to ROMAN8 when it is loaded into Adaptive Server. For clients using Latin 1, the data is reconverted when it is sent to the client; for clients using the same character set as Adaptive Server, the data is not converted. However, if all clients use Latin 1, especially if the data is copied to another Adaptive Server using Latin 1, the System Administrator may want to disable character set conversion entirely. All data is then stored in the client's character set in Adaptive Server.

The configuration parameter **disable character set conversions** controls server-wide character conversion. The default, 0, enables conversions. Client applications can request that no conversion take place.

Changing the Default Character Set, Sort Order, or Language

A System Administrator can change the character set, sort order, or message language used by Adaptive Server. Because a sort order is built on a specific character set, changing character sets always involves a change in sort order. However, you can change the sort order without changing character sets, because more than one sort order may be available for a character set.

This section summarizes the steps to take before and after changing Adaptive Server's character set, sort order, or message language. For procedures on how to configure the character set, sort order, or message language, see the configuration documentation for your platform.

Changing the Default Character Set

Adaptive Server can have only one **default character set**, the character set in which data is stored in its databases. When you install Adaptive Server, you specify a default character set.

◆ ***WARNING!***

Please read the following carefully and exercise extreme caution when changing the default character set in Adaptive Server.

When you change the default character set in Adaptive Server:

- You must convert any existing data to the new default character set:

a. Copy the data out using **bcp**.

b. Change the default character set.

c. Use **bcp** with the appropriate flags for data conversion, to copy the data back into the server.

See the *Utility Programs* manual for your platform for more information about **bcp**.

- Code conversion between the character set of the existing data and the new default character set must be supported. If it is not, conversion errors will occur and the data will not be converted correctly. See Chapter 20, "Configuring Client/Server Character Set Conversions," for more information about supported character set conversions.
- Even if conversions are supported between the character sets, some errors may occur because there are minor differences between the character sets, and some characters do not have equivalents in other character sets. Rows containing problematic data may not get copied back into the database or data may contain partial or invalid characters.

If your existing data is 7-bit ASCII, it does not require conversion to the new default character set. You can change the default without first copying your data out of the server.

Changing the Default Sort Order

Adaptive Server can have only one **default sort order**, the collating sequence it uses to order data. When you consider changing the sort order for character data on a particular Adaptive Server, keep this in mind: all of your organization's Adaptive Servers should have the same sort order. A single sort order enforces consistency and makes distributed processing easier to administer.

You may have to rebuild your indexes. For more information, see "If You Changed the Sort Order or Default Character Set" on page 19-13.

Getting Information About Sort Orders

sp_helpsort displays Adaptive Server's default sort order, character set, and a table of its primary sort orders:

```
sp_helpsort
```

For more information about the different sort orders, see the configuration documentation for your platform.

Database Dumps and Configuration Changes

You can use a database dump if your data does not have to be converted to the new character set and both the old and the new character sets use binary sort order, you can restore your database from backups that were made before the character set was reconfigured.

➤ ***Note***

Back up all databases in Adaptive Server both before and after you change character sets or sort orders.

Usually you cannot reload your data from a database dump you have reconfigured the default character set and sort order.

Do not use a database dump if the following is true. Instead, use **bcp** to copy the data out of and into your databases:

- A database contains 8-bit character data, and you want the data to be converted to the new character set, do not load a database dump of the data into an Adaptive Server with the new default character set. Adaptive Server interprets the data loaded as if it is in the new character set, and the data will be corrupted.
- You are changing only the default sort order and not the default character set. You cannot load a database from a dump that was performed before you changed the sort order. If you attempt to do so, an error message appears, and the load is aborted.
- You change the default character set, and either the old or the new sort order is not binary. You cannot load a database dump that was made before you changed the character set.

Preliminary Steps

Before you run the installation program to reconfigure Adaptive Server:

1. Dump all user databases and the *master* database. If you have made changes to *model* or *sybsystemprocs*, dump them also.
2. Load the language module if it is not already loaded (see the configuration documentation for your platform for complete instructions).

3. If you are changing the Adaptive Server default character set, and your current databases contain non-7-bit data, use **bcp** to copy the existing data out of your databases.

At this point, you can run the Adaptive Server installation program to configure languages, character sets, or sort orders, as well as other options.

Steps to Configure Languages, Character Sets, and Sort Orders

When you install Adaptive Server, the installation program lets you:

- Install or remove message languages and character sets included with Adaptive Server
- Change the default message language or character set
- Select a different sort order

See the configuration documentation for your platform for instructions on using the installation program.

To reconfigure the language, character set, or sort order, use the **sqlloc** utility, described in *Utility Programs for UNIX Platforms*. If you are using Windows NT, use the Server Config utility, described in *Configuring Adaptive Server for Windows NT*. If you are adding a new character set that is not included with Adaptive Server, see the *Sybase Character Sets* manual for complete instructions.

Final Steps

If you installed additional languages but did not change Adaptive Server's character set or sort order, you have completed the reconfiguration process.

If you changed the Adaptive Server default character set, and your current databases contain non-7-bit data, copy your data back into your databases, using **bcp** with the necessary flags to enable conversion.

If you changed Adaptive Server's default sort order or character set, See "If You Changed the Sort Order or Default Character Set" on page 19-13.

Setting the User's Default Language

If you install an additional language, users running client programs can run **sp_modifylogin** to set that language as their default language.

If You Changed the Sort Order or Default Character Set

This section describes recovery after reconfiguration and the steps you may need to follow if you changed Adaptive Server's sort order or default character set.

If you changed sort orders, you need to:

- Run **sp_indsuspect** to find user indexes that may no longer be valid.
- Rebuild suspect user indexes using the **dbcc reindex** command.

For more information, see "Using sp_indsuspect to Find Corrupt Indexes" on page 19-14, and"Rebuilding Indexes After Changing the Sort Order" on page 19-14.

If you changed to a multibyte character set from any other character set (either multibyte or single-byte), you must upgrade any existing *text* values with **dbcc fix_text**. See "Upgrading text Data After Changing Character Sets" on page 19-15 for more information.

Recovery After Reconfiguration

Every time Adaptive Server is stopped and restarted, recovery is performed automatically on each database. Automatic recovery is covered in detail in Chapter 26, "Developing a Backup and Recovery Plan."

After recovery is complete, the new sort order and character set definitions are loaded.

If the sort order has been changed, Adaptive Server switches to single-user mode to allow the necessary updates to system tables and to prevent other users from using the server. Each system table with a character-based index is automatically checked to see if any indexes have been corrupted by the sort order change. Character-based indexes in system tables are automatically rebuilt, if necessary, using the new sort order definition.

After the system indexes are rebuilt, character-based user indexes are marked "suspect" in the *sysindexes* system table, without being checked. User tables with suspect indexes are marked "read-only" in

sysobjects to prevent updates to these tables and use of the "suspect" indexes until they have been checked and, if necessary, rebuilt.

Next, the new sort order information replaces the old information in the area of the disk that holds configuration information. Adaptive Server then shuts down so that it starts for the next session with a "clean slate."

Using *sp_indsuspect* to Find Corrupt Indexes

After Adaptive Server shuts down, restart it, and use **sp_indsuspect** to find the user tables that need to be reindexed. The syntax is:

```
sp_indsuspect [tab_name]
```

where *tab_name* is the optional name of a specific table. If *tab_name* is missing, **sp_indsuspect** creates a list of all tables in the current database that has indexes marked "suspect" when the sort order changes.

In this example, running **sp_indsuspect** in *mydb* database yields one suspect index:

```
sp_indsuspect

Suspect indexes in database mydb
Own.Tab.Ind (Obj_ID, Ind_ID) =
dbo.holdings.h_name_ix(160048003, 2)
```

Rebuilding Indexes After Changing the Sort Order

dbcc reindex checks the integrity of indexes on user tables by running a "fast" version of **dbcc checktable**. For details, see "dbcc checktable" on page 25-11. **dbcc reindex** drops and rebuilds the indexes where the sort order used is not consistent with the new sort order. When **dbcc reindex** discovers the first index-related error, it displays a message, and then rebuilds the inconsistent indexes. The System Administrator or table owner should run **dbcc reindex** after changing the sort order in Adaptive Server.

The syntax is:

```
dbcc reindex ({table_name | table_id})
```

Run this command on all tables listed by **sp_indsuspect** as containing suspect indexes. For example:

```
dbcc reindex(titles)

One or more indexes are corrupt. They will be
rebuilt.
```

In the preceding example, **dbcc reindex** discovers one or more suspect indexes in the table *titles*; it drops and re-creates the appropriate indexes.

If the indexes for a table are already correct, or if there are no indexes for the table, **dbcc reindex** does not rebuild any indexes. It displays a message instead. If a table is suspected of containing corrupt data, the command is aborted. If that happens, an error message instructs the user to run **dbcc checktable**.

When **dbcc reindex** finishes successfully, all "suspect" marks on the table's indexes are removed. The "read only" mark on the table is also removed, and the table can be updated. These marks are removed whether or not any indexes have to be rebuilt.

dbcc reindex does not reindex system tables. System indexes are checked and rebuilt, if necessary, as an automatic part of recovery after Adaptive Server is restarted following a sort order change.

Upgrading *text* Data After Changing Character Sets

The **dbcc fix_text** command upgrades *text* values after you have changed an Adaptive Server's character set to a **multibyte character set**.

The syntax is:

```
dbcc fix_text ({table_name | table_id})
```

Changing to a multibyte character set makes the management of *text* data more complicated. A *text* value can be large enough to cover several pages; therefore, Adaptive Server must be able to handle characters that span page boundaries. To do so, Adaptive Server requires additional information on each of the *text* pages. The System Administrator or table owner must run **dbcc fix_text** on each table that has *text* data to calculate the new values needed.

To see the names of all tables that contain *text* data, use:

```
select sysobjects.name
from sysobjects, syscolumns
where syscolumns.type = 35
and sysobjects.id = syscolumns.id
```

The System Administrator or table owner must run **dbcc fix_text** to calculate the new values needed.

The syntax of **dbcc fix_text** is:

```
dbcc fix_text (table_name | table_id)
```

The table named must be in the current database.

dbcc fix_text opens the specified table, calculates the character statistics required for each *text* value, and adds the statistics to the appropriate page header fields. This process can take a long time, depending on the number and size of the *text* values in a table. **dbcc fix_text** can generate a large number of log records, which may fill up the transaction log. **dbcc fix_text** performs updates in a series of small transactions so that if a log becomes full, only a small amount of work is lost.

If you run out of log space, clear out your log (see Chapter 27, "Backing Up and Restoring User Databases"). Then, restart **dbcc fix_text**, using the same table that was being upgraded when the original **dbcc fix_text** halted. Each multibyte text value contains information that indicates whether it has been upgraded, so **dbcc fix_text** upgrades only the *text* values that were not processed in earlier passes.

If your database stores its log on a separate segment, you can use thresholds to manage clearing the log. See Chapter 29, "Managing Free Space with Thresholds."

If **dbcc fix_text** cannot acquire a needed lock on a text page, it reports the problem and continues with the work, like this:

```
Unable to acquire an exclusive lock on text page
408. This text value has not been recalculated.
In order to recalculate those TEXT pages you must
release the lock and reissue the dbcc fix_text
command.
```

Retrieving *text* Values After Changing Character Sets

If you attempt to retrieve *text* values after changing to a multibyte character set, and you have not run **dbcc fix_text**, the command fails with this error message:

```
Adaptive Server is now running a multi-byte
character set, and this TEXT column's character
counts have not been recalculated using this
character set. Use dbcc fix_text before running
this query again.
```

Installing Date Strings for Unsupported Languages

You can use **sp_addlanguage** to install names for the days of the week and months of the year for languages that do not have language modules. With **sp_addlanguage**, you define:

- A language name and (optionally) an alias for the name
- A list of the full names of months and a list of abbreviations for the month names
- A list of the full names of the days of the week
- The date format for entering dates (such as month / day / year)
- The number of the first day of the week

This example adds the information for Italian:

```
sp_addlanguage italian, italiano,
"gennaio,febbraio,marzo,aprile,maggio,giugno,luglio,agosto,settem
bre,ottobre,novembre,dicembre",
"genn,feb,mar,apr,mag,giu,lug,ago,sett,ott,nov,dic",
"lunedi,martedi,mercoledi,giovedi,venerdi,sabato,domenica",
dmy, 1
```

sp_addlanguage enforces strict data entry rules. The lists of month names, month abbreviations, and days of the week must be comma-separated lists with no spaces or line feeds (returns). Also, they must contain the correct number of elements (12 for month strings, 7 for day-of-the-week strings.)

Valid values for the date formats are: *mdy*, *dmy*, *ymd*, *ydm*, *myd*, and *dym*. The *dmy* value indicates that the dates are in day / month / year order. This format affects only data entry; to change output format, you must use the **convert** function.

Server vs. Client Date Interpretation

Generally, date values are resolved on the client. When a user selects date values, Adaptive Server sends them to the client in internal format. The client uses the *common.loc* file and other localization files in the default language subdirectory of the *locales* directory on the client to convert the internal format to character data. For example, if the user's default language is Spanish, Adaptive Server looks for the *common.loc* file in */locales/spanish/char_set*. It uses the information in the file to display, for example, *12 febrero 1997*.

Assume that the user's default language is set to Italian, a language for which Adaptive Server does not provide a language module, and

that the date values in Italian have been added. When the client connects to the server and looks for the *common.loc* file for Italian, it will not find the file. The client prints an error message and connects to the server. If the user then selects date values, the dates are displayed in U.S. English format.To display the date values added with **sp_addlanguage**, use the **convert** function to force the dates to be converted to character data at the server.

The following query generates a result set with the dates in U.S. English format:

```
select pubdate from titles
```

whereas the query below returns the date with the month names in Italian:

```
select convert(char(19),pubdate) from titles
```

20 Configuring Client / Server Character Set Conversions

This chapter describes how to configure character-set conversion when the client uses a different character set than Adaptive Server. Topics include:

Character-Set Conversion in Adaptive Server

Clients that use different character encoding schemes can connect to the same Adaptive Server. In a Western European setting, for example, a server that runs in an ISO 8859-1 (iso_1) environment may be connected to a client that runs in a CP 850 (cp850) environment. Although different character sets may support the same language group (for example, ISO 8859-1 and CP 850 support the Western European languages), they encode the same characters differently. For example, in ISO 8859-1 the character *à* is encoded as *0xE0*. However, in CP 850 the same character is encoded as *0x85*.

This chapter describes the character set conversion features of Adaptive Server and the utilities **isql**, **bcp**, and **defncopy**.

Conversion Paths Supported

In order to maintain data integrity between your clients and servers, data must be converted between the character sets. This conversion is known as **character set conversion** or **codeset conversion**. Adaptive Server supports character set conversion among the character sets within each language group (Table 19-1).

An additional character set, ASCII 7 (ascii_7), is compatible with all character sets. If either the Adaptive Server or the client's character set is ASCII 7, any 7-bit ASCII character can pass between the client and server unaltered. Other characters produce conversion errors.

Characters That Cannot Be Converted

In converting one character set to another, some characters may not be converted. Here are two possibilities:

- The character exists (is encoded) in the source character set, but it does not exist in the target character set. For example, the character "Œ," the OE ligature, is part of the Macintosh character set (code point 0xCE). This character does not exist in the ISO 8859-1 character set. If "Œ" exists in data that is being converted from the Macintosh to the ISO 8859-1 character set, it causes a conversion error.
- The character exists in both the source and the target character set, but in the target character set, the character is represented by a different number of bytes than in the source character set. Figure 20-1 compares the EUC JIS and Shift-JIS encodings for the same sequence of characters in a Japanese environment. Kanji, Hiragana, Hankaku Romaji, Zenkaku Romaji, and Zenkaku Katakana characters are represented by the same number of bytes in both character sets and can be converted between EUC-JIS and Shift-JIS. However, Hankaku Katakana characters (the last set of characters in the example) are represented by two bytes in EUC-JIS and by a single byte in Shift-JIS. These characters cannot be converted.

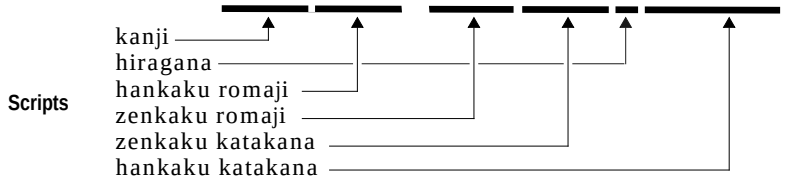


Figure 20-1: Comparison of EUC-JIS and Shift-JIS encoding for Japanese characters

In addition to Hankaku Katakana, user-defined characters (Gaiji) cannot be converted between Japanese character sets.

You can get around this limitation by configuring the **enable unicode conversion** option to 1 or 2. Your client must be using the appropriate version of TDS.

Error Handling in Character Set Conversion

Adaptive Server's character-set conversion filters report conversion errors when a character exists in the client's character set but not in the server's character set, or vice versa. Adaptive Server must guarantee that data successfully converted on input to the server can be successfully converted back to the client's character set when the client retrieves that data. To do this effectively, Adaptive Server must avoid putting suspect data into the database.

When Adaptive Server encounters a conversion error in the data being entered, it generates this error message:

```
Msg 2402, Severity 16 (EX_USER):
Error converting client characters into server's
character set. Some character(s) could not be
converted.
```

A conversion error prevents query execution.

When Adaptive Server encounters a conversion error while sending data to the client, it replaces the bytes of the suspect characters with ASCII question marks (?). However, the query batch continues to completion. When the statement is complete, Adaptive Server sends the following message:

```
Msg 2403, Severity 16 (EX_INFO):
WARNING! Some character(s) could not be converted
into client's character set. Unconverted bytes
were changed to question marks ('?').
```

See "Controlling Character Conversion During a Session" on page 20-5 to learn how to turn off error reporting for data being sent from server to client.

Setting Up the Conversion Process

Character-set conversion begins at login or when the client requests conversion with the **set char_convert** command during a work session. If the client is using Open Client DB-Library version 4.6 or later, and the client and Adaptive Server are using different character sets, conversion is turned on during the login process and is set to a default, based on the character set that the client is using. Character-

set conversion can be controlled in the standalone utilities **isql**, **bcp**, and **defncopy** with a command line option. See "Display and File Character Set Command Line Options" on page 20-9 for details.

When a client requests a connection, Adaptive Server determines whether it can convert from the client's character set to its own character set. If it can, it sets up the appropriate character-set conversion filters so that any character data read from or sent to the client automatically passes through them. Next, Adaptive Server checks the user name and password. These have already been read and must be converted. If they cannot be converted, the login is denied. If conversion on the name and password succeeds, Adaptive Server looks up the converted strings in *syslogins*.

If Adaptive Server cannot perform the requested conversions, it sends an error message to the client.

Next, Adaptive Server tries to find the user name and password in their unconverted form in *syslogins*. If it cannot find them, the login is denied. If it succeeds, the login is granted, but no character set conversion takes place.

➤ ***Note***

Machine names, user names, and passwords in heterogeneous environments should be composed entirely of 7-bit ASCII characters. If the client's request for character-set conversion fails, the login still succeeds, if Adaptive Server finds the unconverted user name and password in *syslogins*.

If the request for conversion fails, or if the client's character set is set to ascii_7, the language for the session is forced to us_english. If the user had requested a different language, an informational message would appear, stating that the language for the session was being forced to us_english.

Specifying the Character Set for Utility Programs

A command line option for the **isql**, **bcp**, and **defncopy** utilities specifies the client's character set.

Here are the choices:

- **-J** *charset_name (*UNIX and PC*)* sets the client's character set to the *charset_name*.

- **-J** or **/clientcharset** with no character set name sets the client's character set to NULL. No conversion takes place, and no message is sent.

Omitting the client character set's command line flag sets the character set to a default for the platform. This default may not be the character set that the client is using. See the *Utility Programs* manual for your platform for information.

Controlling Character Conversion During a Session

The **set char_convert** command determines how character set conversion operates during a particular work session.

```
set char_convert {off |
                 {on [with {error | no_error}]} |
                 charset [with {error | no_error}]}
```

Depending on the arguments, the command:

- Turns character-set conversion on and off between Adaptive Server and a client, when used with **off** or **on**:

  ```
  set char_convert off
  ```

  set char_convert off turns conversion off so that characters are sent and received unchanged. **set char_convert on** turns conversion back on after it was turned off. If character set conversion was not turned on during the login process or by the **set char_convert** *charset* command, then **set char_convert on** generates an error message.

- Turns off the printing of error messages when the **with no_error** option is included. When you use **with no_error**, Adaptive Server does not notify the application when characters from Adaptive Server cannot be converted to the client's character set. Error reporting is initially set to "on" when a client connects with Adaptive Server. If you do not want error reporting, you must turn it off for each session. To turn error reporting back on within a session, use **set char_convert on with error.**

  Whether or not error reporting is turned on, the bytes that cannot be converted are replaced with ASCII question marks (?).

- Starts conversion between the server character set and a different client character set, when used with a *charset* value. *charset* can be either the character set's *id* or its *name* from *syscharsets*:

  ```
  set char_convert "cp850"
  ```

If you request character-set conversion with **set char_convert** *charset*, and Adaptive Server cannot perform the requested conversion, the conversion state remains the same as it was before the request. For example, if character-set conversion is off prior to the **set char_convert** *charset* command, conversion remains off if the request fails.

If the user is using a language other than us_english before entering this command:

```
set char_convert "ascii_7"
```

the language for the session is forced to us_english and an informational message appears. No message appears if the session is already in us_english.

Character-Set Conversions That Change Data Lengths

In some cases, the character set used on a server is different from the character set used on a client, and converting data from the server's character set to the client's character set changes the length of the data. This is always the case, for example, when the character set on one system uses 1 byte to represent each character and the character set on the other system requires 2 bytes per character. Adaptive Server, not the client, converts all supported character sets.

When a server-to-client character-set conversion causes a change in data length, there are two possibilities:

- Server-to-client data length decreases

  Examples in which data length decreases from server to client are:

  - Multibyte UTF-8 Greek or Russian to a single-byte Greek or Russian character set
  - Japanese character-set conversion from 2-byte Hankaku-Katakana EUC-JIS to single-byte Shift-JIS

- Server-to-client data length increases

  Examples in which data length increases from server to client are:

  - Single-byte Thai to multibyte UTF-8 Thai
  - Japanese character-set conversion from single-byte Shift-JIS to 2-byte Hankaku-Katakana EUC-JIS

Note that:

- The server automatically and transparently carries out character-set conversions that decrease server-to-client data length.
- You can configure the server to carry out character-set conversions that increase server-to-client data length.

➤ ***Note***

bcp, **isql**, **defncopy,** and **optdiag** utility programs can receive character-set conversions that reduce data length, but they cannot receive character-set conversions from the server that increase data length.

The remainder of this section describes server-performed character-set conversions that increase data length. For background information on supported character sets and character-set conversion, see the configuration documentation for your platform and Chapter 19, "Configuring Character Sets, Sort Orders, and Languages," in this manual.

Conversions When Server-to-Client Data Length Increases

To enable and make use of character-set conversions on the server that increase data length:

- On the server, use **sp_configure** to enable Unicode conversions.
- On the client, you need to be able to handle CS_LONGCHAR data, and you need to inform the server of this capability at connection time, using the Open Client **ct_capability** function.

Configuring the Server

Adaptive Server supports Unicode conversion, in which the server performs character-set conversions by first converting its local character set to Unicode and then converting the resulting Unicode to the destination character set. Unicode conversion is necessary when the server is not able to perform a character-set conversion directly from one character set to another. It is available as a configuration option set through **sp_configure**.

Adaptive Server allows Unicode conversions that change data length. In server-to-client character-set conversions that decrease data length, the server automatically performs the conversion. In server-to-client character-set conversions that increase data length,

configure the server explicitly by setting **enable unicode conversions** to either 1 or 2.

- If you set **enable unicode conversions** to 1:

  ```
  sp_configure "enable unicode conversions", 1
  ```

  Adaptive Server first looks for a converter that directly maps the server's character set to the client's character set. Direct converters are not available for mappings that change data length. If it cannot find a direct converter, Adaptive Server carries out a Unicode conversion.

- If you set **enable unicode conversions** to 2:

  ```
  sp_configure "enable unicode conversions", 2
  ```

  Adaptive Server carries out a Unicode conversion, without attempting to find a converter for a direct character-set mapping.

Client Requirements

To make use of a server-performed character-set conversion that increases data length:

- A client application must use Client-Library version 11.1 or later.
- The client must be able to handle CS_LONGCHAR data.

  When the server carries out a character-set conversion that increases data length, *char* and *varchar* data is converted to the client's character set and sent to the client as CS_LONGCHAR data. Thus, to make use of server-side character-set conversions that increase data length, a client application must be coded to extract its own character set from data received as CS_LONGCHAR.

- In establishing a connection with a server, a client application must call the Open Client **ct_capability** function with the *capability* parameter set to CS_DATA_LCHAR and the *value* parameter set to CS_TRUE:

  ```
  CS_INT capval = CS_TRUE
  ct_capability(connection,CS_SET,CS_CAP_RESPONSE,
     CS_DATA_LCHAR,&capval)
  ```

  where *connection* is a pointer to a CS_CONNECTION structure.

Display and File Character Set Command Line Options

Although the focus of this chapter is on character-set conversion between client and Adaptive Server, there are two other places where you may need character set conversion:

- Between the client and a terminal
- Between the client and a file system

Figure 20-2 illustrates the paths and command line options that are available in the standalone utilities **isql**, **bcp**, and **defncopy**.

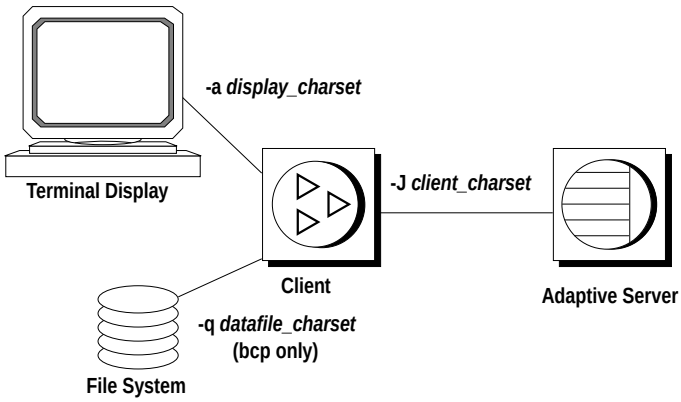


Figure 20-2: Where character set conversion may be needed

As described earlier, the **-J** or **/clientcharset** command line option specifies the character set used by the client when it sends and receives character data to and from Adaptive Server.

Setting the Display Character Set

Use the **-a** command line option if you are running the client from a terminal with a character set that differs from the client character set. In Figure 20-2, the **-a** option and the **-J** option are used together to identify the character-set translation file (*.xlt* file) needed for the conversion.

Use **-a** without **-J** only if the client character set is the same as the default character set.

Setting the File Character Set

Use the **-q** command line option if you are running **bcp** to copy character data to or from a file system that uses a character set that differs from the client character set. In Figure 20-2, use the **-q** or **/filecharset** option and the **-J** or **/clientcharset** option together to identify the character set translation file (*.xlt* file) needed for the conversion.

Managing Databases and Database Objects

21 Creating and Managing User Databases

This chapter explains how to create and manage user databases. Topics include:

Commands for Creating and Managing User Databases

Table 21-1 summarizes the commands for creating, modifying, and dropping user databases and their transaction logs.

Table 21-1: Commands for managing user databases

Command	Task
create database...on *dev_name* or **alter database...on** *dev_name*	Makes database devices available to a particular Adaptive Server database.. When used without the **on** *dev_name* clause, these commands allocate space from the default pool of database devices.
dbcc checktable(syslogs)	Reports the size of the log.
sp_logdevice	Specifies a device that will store the log when the current log device becomes full.
sp_helpdb	Reports information about a database's size and devices.

Table 21-1: Commands for managing user databases (continued)

Command	Task
sp_spaceused	Reports a summary of the amount of storage space used by a database.

Permissions for Managing User Databases

By default, only the System Administrator has **create database** permission. The System Administrator can grant permission to use the **create database** command. However, in many installations, the System Administrator maintains a monopoly on **create database** permission to centralize control of database placement and database device allocation. In these situations, the System Administrator creates new databases on behalf of other users and then transfers ownership to the appropriate user(s).

To create a database and transfer ownership to another user, the System Administrator:

1. Issues the **create database** command.
2. Switches to the new database with the **use** *database* command.
3. Executes **sp_changedbowner**, as described in "Changing Database Ownership" on page 21-11.

When a System Administrator grant permission to create databases, the user that receives the permission must also be a valid user of the *master* database, since all databases are created while using *master*.

The fact that System Administrators seem to operate outside the protection system serves as a safety precaution. For example, if a Database Owner forgets his or her password or accidentally deletes all entries in *sysusers*, a System Administrator can repair the damage using the backups or dumps that are made regularly.

Permission **alter database** or **drop database** defaults to the Database Owner, and permission is automatically transferred with database ownership. **alter database** and **drop database** permission cannot be changed with **grant** or **revoke.**

Using the *create database* Command

Use **create database** to create user databases. You must have **create database** permission, and you must be a valid user of *master*. Always type **use master** before you create a new database.

➤ ***Note***

Each time you enter the **create database** command, dump the *master* database. This makes recovery easier and safer in case *master* is later damaged. See Chapter 28, "Restoring the System Databases," for more information.

create database Syntax

The **create database** syntax is:

```
create database database_name
   [on {default | database_device} [= size]
       [, database_device [= size]...]
   [log on database_device [ = size ]
       [, database_device [= size]]...]
   [with override]
   [for load]
```

A database name must follow the rules for identifiers. You can create only one database at a time.

In its simplest form, **create database** creates a database on the default database devices listed in *master..sysdevices*:

```
create database newpubs
```

You can control different characteristics of the new database by using the **create database** clauses:

- The **on** clause specifies the names of one or more database devices and the space allocation, in megabytes, for each database device. See "Assigning Space and Devices to Databases" on page 21-5 for more information.
- The **log on** clause places the **transaction log** (the *syslogs* table) on a separate database device with the specified or default size. See "Placing the Transaction Log on a Separate Device" on page 21-7 for more information.
- **for load** causes Adaptive Server to skip the page-clearing step during database creation. Use this clause if you intend to load a

dump into the new database as the next step. See "Using the for load Option for Database Recovery" on page 21-10 for more information.

- **with override** allows Adaptive Servers on machines with limited space to maintain their logs on device fragments that are separate from their data. Use this option **only** when you are putting log and data on the same logical device. See "Using the with override Option with create database" on page 21-11 for more information.

How *create database* Works

When a user with the required permission issues **create database**, Adaptive Server:

- Verifies that the database name specified is unique.
- Makes sure that the database device names specified are available.
- Finds an unused identification number for the new database.
- Assigns space to the database on the specified database devices and updates *master..sysusages* to reflect these assignments.
- Inserts a row into *sysdatabases*.
- Makes a copy of the *model* database in the new database space, thereby creating the new database's system tables.
- Clears all the remaining pages in the database device. If you are creating a database to load a database dump, **for load** skips page clearing, which is performed after the load completes).

The new database initially contains a set of system tables with entries that describe the system tables themselves. The new database inherits all the changes you have made to the *model* database, including:

- The addition of user names.
- The addition of objects.
- The database option settings. Originally, the options are set to "off" in *model*. If you want all of your databases to inherit particular options, change the options in *model* with **sp_dboption**. See Chapter 2, "System Databases," for more information about *model*. See Chapter 22, "Setting Database Options," for more information about changing database options.

Adding Users to Databases

After creating a new database, the System Administrator or Database Owner can manually add users to the database with **sp_adduser**. This task can be done with the help of the System Security Officer, if new Adaptive Server logins are required. See "Security Administration" for details on managing Adaptive Server logins and database users.

Assigning Space and Devices to Databases

Adaptive Server allocates storage space to databases when a user enters the **create database** or **alter database** command. **create database** can specify one or more database devices, along with the amount of space on each that is to be allocated to the new database.

➤ ***Note***

You can also use the **log on** clause to place a production database's transaction log on a separate device. See "Placing the Transaction Log on a Separate Device" on page 21-7 for more information.

If you use the **default** keyword, or if you omit the **on** clause, Adaptive Server puts the database on one or more of the default database devices specified in *master..sysdevices*. See "Designating Default Devices" on page 12-9 for more information about the default pool of devices.

To specify a size (4MB in the following example) for a database that is to be stored in a default location, use **on default = size** like this:

```
create database newpubs
on default = 4
```

To place the database on specific database devices, give the name(s) of the database device(s) where you want it stored. You can request that a database be stored on more than one database device, with a different amount of space on each. All the database devices named in **create database** must be listed in *sysdevices*. In other words, they must have been initialized with **disk init**. See Chapter 12, "Initializing Database Devices," for instructions about using **disk init**.

The following statement creates the *newdb* database and allocates 3MB on *mydata* and 2MB on *newdata*. The database and transaction log are not separated:

```
create database newdb
on mydata = 3, newdata = 2
```

◆ ***WARNING!***

Unless you are creating a small or noncritical database, always place the log on a separate database device. Follow the instructions under "Placing the Transaction Log on a Separate Device" on page 21-7 to create production databases.

If the amount of space you request on a specific database device is unavailable, Adaptive Server creates the database with as much space as possible on each device and displays a message informing you how much space it has allocated on each database device. This is not considered an error. If there is less than the minimum space necessary for a database on the specified database device, **create database** fails.

If you create (or alter) a database on a UNIX device file that does not use the **dsync** setting, Adaptive Server displays an error message in the error log file. For example, if you create the "mydata" device in the previous example does not use **dsync**, you would see a message similar to:

```
Warning: The database 'newdb' is using an unsafe virtual device
'mydata'. The recovery of this database can not be guaranteed.
```

Default Database Size and Devices

If you omit the size parameter in the **on** clause, Adaptive Server creates the database with a default amount of space. This amount is the larger of the sizes specified by the **default database size** configuration parameter and the *model* database.

The size of *model* and the value of **default database size** are initially set to 2MB. To change the size of *model*, allocate more space to it with **alter database**. To change the **default database size** configuration parameter, use **sp_configure**. Changing **default database size** enables you to set the default size for new databases to any size between 2MB and 10,000MB. See "default database size" on page 17-121 for complete instructions.

If you omit the **on** clause, the database is created as the default size, as described above. The space is allocated in alphabetical order by database device name, from the default database devices specified in *master..sysdevices*.

To see the logical names of default database devices, enter:

```
select name
    from sysdevices
    where status & 1 = 1
    order by name
```

sp_helpdevice also displays "default disk" as part of the description of database devices.

Estimating the Required Space

The size allocation decisions you make are important, because it is difficult to reclaim storage space after it has been assigned. You can always add space; however, you cannot de-allocate space that has been assigned to a database, unless you drop the database first.

You can estimate the size of the tables and indexes for your database by using **sp_estspace** or by calculating the value. See Chapter 15, "Determining or Estimating the Sizes of Tables and Indexes," in the *Performance and Tuning Guide* for instructions.

Placing the Transaction Log on a Separate Device

Use the **log on** clause of the **create database** command to place the **transaction log** (the *syslogs* table) on a separate database device. Unless you are creating very small, noncritical databases, always place the log on a separate database device. Placing the logs on a separate database device:

- Lets you use **dump transaction**, rather than **dump database**, thus saving time and tapes.
- Lets you establish a fixed size for the log to keep it from competing for space with other database activity.
- Creates default free-space threshold monitoring on the log segment and allows you to create additional free-space monitoring on the log and data portions of the database. See Chapter 29, "Managing Free Space with Thresholds," for more information.
- Improves performance.
- Ensures full recovery from hard disk crashes. A special argument to **dump transaction** lets you dump your transaction log, even when your data device is on a damaged disk.

To specify a size and device for the transaction log, use the **log on *device* = *size*** clause to **create database**. For example, the following statement creates the *newdb* database, allocates 8MB on *mydata* and 4MB on *newdata*, and places a 3MB transaction log on a third database device, *tranlog*:

```
create database newdb
on mydata = 8, newdata = 4
log on tranlog = 3
```

Estimating the Transaction Log Size

The size of the transaction log is determined by:

- The amount of update activity in the associated database
- The frequency of transaction log dumps

This is true whether you perform transaction log dumps manually or use threshold procedures to automate the task. As a general rule, allocate to the log 10 to 25 percent of the space that you allocate to the database.

Inserts, deletes, and updates increase the size of the log. **dump transaction** decreases its size by writing committed transactions to disk and removing them from the log. Since **update** statements require logging the "before" and "after" images of a row, applications that update many rows at once should plan on the transaction log being at least twice as large as the number of rows to be updated at the same time, or twice as large as your largest table. Or you can **batch** the updates in smaller groups, performing transaction dumps between the batches.

In databases that have a lot of insert and update activity, logs can grow very quickly. To determine the required log size, periodically check the size of the log. This will also help you choose thresholds for the log and scheduling the timing of transaction log dumps. To check the space used by a database's transaction log, first use the database. Then enter:

```
dbcc checktable(syslogs)
```

dbcc reports the number of data pages being used by the log. If your log is on a separate device, **dbcc checktable** also tells you how much space is used and how much is free. Here is sample output for a 2MB log:

```
Checking syslogs
The total number of data pages in this table is 199.
*** NOTICE: Space used on the log segment is 0.39 Mbytes, 19.43%.
*** NOTICE: Space free on the log segment is 1.61 Mbytes, 80.57%.
Table has 1661 data rows.
```

You can also use the following Transact-SQL statement to check on the growth of the log:

```
select count(*) from syslogs
```

Repeat either command periodically to see how fast the log grows.

Default Log Size and Device

If you omit the *size* parameter in the **log on** clause, Adaptive Server allocates 2MB of storage on the specified log device. If you omit the **log on** clause entirely, Adaptive Server places the 2MB transaction log on the same database device as the data tables.

Moving the Transaction Log to Another Device

If you did not use the **log on** clause to **create database**, follow the instructions in this section to move your transaction log to another database device.

sp_logdevice moves the transaction log of a database with log and data on the same device to a separate database device. However, the transaction log remains on the original device until the allocated page has been filled and the transaction log has been dumped.

➤ ***Note***

If the log and its database share the same device, subsequent use of **sp_logdevice** affects only future writes to the log; it does not immediately move the first few log pages that were written when the database was created. This creates exposure problems in certain recovery situations, and is not recommended.

The syntax for **sp_logdevice** is:

sp_logdevice ***database_name, devname***

The database device you name must be initialized with **disk init** and must be allocated to the database with **create** or **alter database.**

To move the entire transaction log to another device:

1. Execute **sp_logdevice**, naming the new database device.
2. Execute enough transactions to fill the page that is currently in use. Since a page contains 2048 bytes, you may need to update at least 2048 bytes. You can execute **dbcc checktable(syslogs)** before and after you start updating to determine when a new page is used.
3. Wait for all currently active transactions to finish. You may want to put the database into single-user mode with **sp_dboption**.
4. Run **dump transaction**, which removes all the log pages that it writes to disk. As long as there are no active transactions in the part of the log on the old device, all of those pages will be removed. See Chapter 26, "Developing a Backup and Recovery Plan," for more information.
5. Run **sp_helplog** to ensure that the complete log is on the new log device.

➤ ***Note***

When you move a transaction log, the space no longer used by the transaction log becomes available for data. However, you cannot reduce the amount of space allocated to a device by moving the transaction log.

Transaction logs are discussed in detail in Chapter 26, "Developing a Backup and Recovery Plan."

Using the *for load* Option for Database Recovery

Adaptive Server generally clears all unused pages in the database device when you create a new database. Clearing the pages can take several seconds or several minutes to complete, depending on the size of the database and the speed of your system.

Use the **for load** option if you are going to use the database for loading from a database dump, either for recovery from media failure or for moving a database from one machine to another. Using **for load** runs a streamlined version of **create database** that skips the page-clearing step, and creates a target database that can be used **only** for loading a dump.

If you create a database using **for load**, you can run only the following commands in the new database before loading a database dump:

- **alter database...for load**

- **drop database**
- **load database**

When you load a database dump, the new database device allocations for the database need to match the usage allocations in the dumped database. See Chapter 27, "Backing Up and Restoring User Databases," for a discussion of duplicating space allocation.

After you load the database dump into the new database, there are no restrictions on the commands you can use.

Using the *with override* Option with *create database*

This option allows machines with limited space to maintain their logs on device fragments that are separate from their data. Use this option **only** when you put log and data on the same logical device. Although this is not recommended practice, it may be the only option available on machines with limited storage, especially if you need to get databases back online following a hard disk crash.

You will still be able to dump your transaction log, but if you experience a media failure, you will not be able to access the current log, since it is on the same device as the data. You will be able to recover only to the last transaction log dump, and all transactions between that point and the failure time will be lost.

In the following example, the log and data are on separate fragments of the same logical device:

```
create database littledb
    on diskdev1 = 4
    log on diskdev1 = 1
    with override
```

Changing Database Ownership

A System Administrator might want to create the user databases and give ownership of them to another user after completing some of the initial work. **sp_changedbowner** changes the ownership of a database. The procedure must be executed by the System Administrator in the database where the ownership will be changed. The syntax is:

```
sp_changedbowner loginame [, true ]
```

The following example makes the user "albert" the owner of the current database and drops the aliases of users who could act as the former "dbo."

```
sp_changedbowner albert
```

The new owner must already have a login name in Adaptive Server, but he or she cannot be a user of the database or have an alias in the database. You may have to use **sp_dropuser** or **sp_dropalias** before you can change a database's ownership. See the Chapter 5, "Security Administration," for more information about changing ownership.

To transfer aliases and their permissions to the new Database Owner, add the second parameter, **true**.

➤ ***Note***

You cannot change ownership of the *master* database. It is always owned by the "sa" login.

Using the *alter database* Command

When your database or transaction log grows to fill all the space allocated with **create database**, you can use **alter database** to add storage. You can add space for database objects or the transaction log, or both. You can also use **alter database** to prepare to load a database from backup.

Permission for **alter database** defaults to the Database Owner, and is automatically transferred with database ownership. For more information, see "Changing Database Ownership" on page 21-11. **alter database** permission cannot be changed with **grant** or **revoke**.

alter database Syntax

To extend a database, and to specify where storage space is to be added, use the full **alter database** syntax:

```
alter database database_name
     [on {default | database_device} [= size]
         [, database_device [= size]]...]
     [log on  {default | database_device} [= size]
         [, database_device [= size]]...]
     [with override]
     [for load]
```

In its simplest form, **alter database** adds 1MB from the default database devices. If your database separates log and data, the space you add is used only for data. Use **sp_helpdevice** to find names of database devices that are in your default list.

To add 1MB from a default database device to the *newpubs* database, enter:

```
alter database newpubs
```

The **on** and **log on** clauses operate like the corresponding clauses in **create database**. You can specify space on a default database device or some other database device, and you can name more than one database device. If you use **alter database** to extend the *master* database, you can extend it only on the master device. The minimum increase you can specify is 1MB (512 2K pages).

To add 3MB to the space allocated for the *newpubs* database on the database device named *pubsdata1*, enter:

```
alter database newpubs
on pubsdata1 = 3
```

If Adaptive Server cannot allocate the requested size, it allocates as much as it can on each database device, with a minimum allocation of .5MB (256 2K pages) per device. When **alter database** completes, it prints messages telling you how much space it allocated; for example:

```
Extending database by 1536 pages on disk pubsdata1
```

Check all messages to make sure the requested amount of space was added.

The following command adds 2MB to the space allocated for *newpubs* on *pubsdata1*, 3MB on a new device, *pubsdata2*, and 1MB for the log on *tranlog*:

```
alter database newpubs
on pubsdata1 = 2, pubsdata2 = 3
log on tranlog
```

➤ ***Note***

Each time you issue the **alter database** command, dump the *master* database.

Use **with override** to create a device fragment containing log space on a device that already contains data or a data fragment on a device already in use for the log. Use this option only when you have no other storage options and when up-to-the-minute recoverability is not critical.

Use **for load** only after using **create database for load** to re-create the space allocation of the database being loaded into the new database from a

dump. See Chapter 27, "Backing Up and Restoring User Databases," for a discussion of duplicating space allocation when loading a dump into a new database.

Using the *drop database* Command

Use **drop database** to remove a database from Adaptive Server, thus deleting the database and all the objects in it. This command:

- Frees the storage space allocated for the database
- Deletes references to the database from the system tables in the *master* database

Only the Database Owner can drop a database. You must be in the *master* database to drop a database. You cannot drop a database that is open for reading or writing by a user.

The syntax is:

```
drop database database_name [, database_name]...
```

You can drop more than one database in a single statement; for example:

```
drop database newpubs, newdb
```

You must drop all databases from a database device before you can drop the database device itself. The command to drop a device is **sp_dropdevice**.

After you drop a database, dump the *master* database to ensure recovery in case *master* is damaged.

System Tables That Manage Space Allocation

To create a database on a database device and allocate a certain amount of space to it, Adaptive Server first makes an entry for the new database in *sysdatabases*. Then, it checks *master..sysdevices* to make sure that the device names specified in **create database** actually exist and are database devices. If you did not specify database devices, or used the **default** option, Adaptive Server checks *master..sysdevices* and *master..sysusages* for free space on all devices that can be used for default storage. It performs this check in alphabetical order by device name.

The storage space from which Adaptive Server gathers the specified amount of storage need not be contiguous. The database storage space can even be drawn from more than one database device. A

database is treated as a logical unit, even if it is stored on more than one database device.

Each piece of storage for a database must be at least 1 allocation unit—1/2MB, or 256 contiguous 2K pages. The first page of each allocation unit is the allocation page. It does not contain database rows like the other pages, but contains an array that shows how the other 255 pages are used.

The *sysusages* Table

The database storage information is listed in *master..sysusages*. Each row in *master..sysusages* represents a space allocation assigned to a database. Thus, each database has one row in *sysusages* for each time **create database** or **alter database** assigns a fragment of disk space to it.

When you install Adaptive Server, *sysusages* contains rows for these *dbids*:

- 1, the *master* database
- 2, the temporary database, *tempdb*
- 3, the *model* database
- 4, the *sybsystemprocs* database

If you installed auditing, the *sybsecurity* database will be *dbid* 5.

➤ ***Note***

If you are upgrading from a pre-version 10.0 SQL Server, *sybsystemprocs* and *sybsecurity* may have different database IDs.

As new databases are created or current databases enlarged, new rows are added to *sysusages* to represent new database allocations.

Here is what *sysusages* might look like on an Adaptive Server with the five system databases and two user databases (with *dbid*s 6 and 7). Both user databases were created with the **log on** option. The database with *dbid* 7 has been given additional storage space with two **alter database** commands:

```
select dbid, segmap, lstart, size, vstart
from sysusages
```

```
dbid   segmap      lstart      size            vstart
------ ----------- ----------- -----------     -------
     1           7           0        1536          4
     2           7           0        1024       2564
     3           7           0        1024       1540
     4           7           0        5120   16777216
     5           7           0       10240   33554432
     6           3           0         512    1777216
     6           4         512         512    3554432
     7           3           0        2048   67108864
     7           4        2048        1024   50331648
     7           3        3072         512   67110912
     7           3        3584        1024   67111424

(10 rows affected)
```

The *segmap* Column

The *segmap* column is a bitmask linked to the *segment* column in the user database's *syssegments* table. Since the *logsegment* in each user database is segment 2, and these user databases have their logs on separate devices, *segmap* contains 4 (2^2) for the devices named in the **log on** statement and 3 for the data segment that holds the system segment ($2^0 = 1$) + default segment ($2^1 = 2$).

Some possible values for segments containing data or logs are:

Value	Segment
3	Data only (system and default segments)
4	Log only
7	Data and log

Values higher than 7 indicate user-defined segments. The *segmap* column is explained more fully in the segments tutorial section in Chapter 23, "Creating and Using Segments."

The *lstart*, *size*, and *vstart* Columns

- *lstart* column – the starting page number in the database of this allocation unit. Each database starts at logical address 0. If additional allocations have been made for a database, as in the case of *dbid* 7, the *lstart* column reflects this.
- *size* column – the number of contiguous 2K pages that are assigned to the same database. The ending logical address of this

portion of the database can be determined by adding the values in *lstart* and *size*.

- *vstart* column – the address where the piece assigned to this database begins. The upper 4 bits store the virtual device number (*vdevno*), and the lower 4 bits store the virtual block number. (To obtain the virtual device number, divide *sysusages.vstart* or *sysdevices.low* by 16,777,216, which is 2^{24}.) The value in *vstart* identifies which database device contains the page number of the database, because it falls between the values in the *low* and *high* columns of *sysdevices* for the database device in question.

Getting Information About Database Storage

This section explains how to determine which database devices are currently allocated to databases and how much space each database uses.

Database Device Names and Options

To find the names of the database devices on which a particular database resides, use **sp_helpdb** with the database name:

```
sp_helpdb pubs2
```

```
name      db_size    owner     dbid created        status
--------- ---------- --------- ---- -------------- --------------
pubs2     2.0 MB     sa           5 Aug 25, 1997   no options set

device_fragments    size          usage            free kbytes
------------------- ------------- ---------------- -----------
pubdev              2.0 MB        data and log             288

device                 segment
---------------------- ----------------------
pubdev                 default
pubdev                 logsegment
pubdev                 system
```

sp_helpdb reports on the size and usage of the devices used by the named database. The status column lists the database options. These options are described in Chapter 22, “Setting Database Options.”

If you are using the named database, **sp_helpdb** also reports on the segments in the database and the devices named by the segments. See Chapter 23, “Creating and Using Segments,” for more information.

When you use **sp_helpdb** without arguments, it reports information about all databases in Adaptive Server:

```
sp_helpdb

name          db_size  owner dbid created      status
------------- -------- ----- ---- ------------ -------------------
master          3.0 MB sa       1 Jan 01, 1900 no options set
model           2.0 MB sa       3 Jan 01, 1900 no options set
mydata          4.0 MB sa       7 Aug 25, 1997 no options set
pubs2           2.0 MB sa       6 Aug 23, 1997 no options set
sybsecurity    20.0 MB sa       5 Aug 18, 1997 no options set
sybsystemprocs 10.0 MB sa       4 Aug 18, 1997 trunc log on chkpt
tempdb          2.0 MB sa       2 Aug 18, 1997 select into/
                                                bulkcopy/pllsort
```

Checking the Amount of Space Used

sp_spaceused provides:

- A summary of space used in the database
- A summary of space used by a table and its indexes and *text/image* storage
- A summary of space used by a table, with separate information on indexes and *text/image* storage.

Checking Space Used in a Database

To get a summary of the amount of storage space used by a database, execute **sp_spaceused** in the database:

```
sp_spaceused

database_name                  database_size
------------------------------ -------------
pubs2                          2.0 MB

reserved      data          index_size      unused
------------- ------------- --------------- --------
1720 KB       536 KB        344 KB          840 KB
```

Table 21-2 describes the columns in the report.

Table 21-2: Columns in sp_spaceused output

Column	Description
database_name	The name of the database being examined.

Table 21-2: Columns in sp_spaceused output

Column	Description
database_size	The amount of space allocated to the database by **create database** or **alter database**.
reserved	The amount of space that has been allocated to all the tables and indexes created in the database. (Space is allocated to database objects inside a database in increments of 1 extent, or 8 pages, at a time.)
data, *index_size*	The amount of space used by data and indexes.
unused	The amount of space that has been reserved but not yet used by existing tables and indexes.

The sum of the values in the *unused*, *index_size*, and *data* columns should equal the figure in the *reserved* column. Subtract *reserved* from *database_size* to get the amount of unreserved space. This space is available for new or existing objects that grow beyond the space that has been reserved for them.

By running **sp_spaceused** regularly, you can monitor the amount of database space available. For example, if the *reserved* value is close to the *database_size* value, you are running out of space for new objects. If the *unused* value is also small, you are running out of space for additional data as well.

Checking Summary Information for a Table

You can also use **sp_spaceused** with a table name as its parameter:

```
sp_spaceused titles
name   rowtotal reserved  data    index_size unused
------ -------- --------- ------- ---------- -----
titles 18       48 KB     6 KB    4 KB       38 KB
```

The *rowtotal* column may be different than the results of running **select count(*)** on the table. This is because **sp_spaceused** computes the value with the built-in function **rowcnt**. That function uses values that are stored in the allocation pages. These values are not updated regularly, however, so they can be very different for tables with a lot of activity. **update statistics**, **dbcc checktable**, and **dbcc checkdb** update the rows-per-page estimate, so *rowtotal* will be most accurate after you have run one of these commands has been run.

You should run **sp_spaceused** regularly on *syslogs*, since the transaction log can grow rapidly if there are frequent database

modifications. This is particularly a problem if the transaction log is not on a separate device—in which case, it competes with the rest of the database for space.

Checking Information for a Table and Its Indexes

To see information on the space used by individual indexes, enter:

```
sp_spaceused titles, 1
```

```
index_name           size       reserved   unused
-------------------- ---------- ---------- ----------
titleidind           2 KB       32 KB      24 KB
titleind             2 KB       16 KB      14 KB

name       rowtotal   reserved   data   index_size unused
---------- --------  ---------  ------- ---------- ----------
titles          18      46 KB     6 KB      4 KB      36 KB
```

Space taken up by the *text/image* page storage is reported separately from the space used by the table. The object name for text/image storage is always "t" plus the table name:

```
sp_spaceused blurbs,1
```

```
index_name           size       reserved   unused
-------------------- ---------- ---------- ----------
blurbs               0 KB       14 KB      12 KB
tblurbs              14 KB      16 KB      2 KB

name       rowtotal reserved    data    index_size unused
---------- -------- ----------- ------- ---------- ----------
blurbs            6       30 KB    2 KB      14 KB      14 KB
```

Querying System Table for Space Usage Information

You may want to write some of your own queries for additional information about physical storage. For example, to determine the total number of 2K blocks of storage space that exist on Adaptive Server, you can query *sysdevices*:

```
select sum(high - low)
from sysdevices
where status in (2, 3)

-------------------
               7168
```

A 2 in the *status* column represents a physical device; a 3 represents a physical device that is also a default device.

22 Setting Database Options

This chapter describes how to use database options. Topics include:

What Are Database Options?

Database options control:

- The behavior of transactions
- Defaults for table columns
- Restrictions to user access
- Performance of recovery and **bcp** operations
- Log behavior

The System Administrator and the Database Owner can use database options to configure the settings for an entire database. Database options differ from **sp_configure** parameters, which affect the entire server, and **set** options, which affect only the current session or stored procedure.

Using the *sp_dboption* Procedure

Use **sp_dboption** to change settings for an entire database. The options remain in effect until they are changed. **sp_dboption**:

- Displays a complete list of the database options when it is used without a parameter
- Changes a database option when used with parameters

You can change options for user databases only. You cannot change options for the *master* database. To change a database option in a user database (or to display a list of the database options), execute **sp_dboption** while using the *master* database.

The syntax is:

```
sp_dboption [dbname, optname, {true | false}]
```

To make an option or options take effect for every new database, change the option in the *model* database.

Database Option Descriptions

All users with access to the *master* database can execute **sp_dboption** with no parameters to display a list of the database options. The report from **sp_dboption** looks like this:

```
sp_dboption

Settable database options.
--------------------
abort tran on log full
allow nulls by default
auto identity
dbo use only
ddl in tran
identity in nonunique index
no chkpt on recovery
no free space acctg
read only
select into/bulkcopy/pllsort
single user
trunc log on chkpt
trunc. log on chkpt.
unique auto_identity index
```

For a report on which options have been set in a particular database, execute **sp_helpdb** in that database.

The following sections describe each database option in detail.

abort tran on log full

abort tran on log full determines the fate of a transaction that is running when the last-chance threshold is crossed. The default value is **false**, meaning that the transaction is suspended and is awakened only when space has been freed. If you change the setting to **true**, all user queries that need to write to the transaction log are killed until space in the log has been freed.

allow nulls by default

Setting **allow nulls by default** to **true** changes the default null type of a column from **not null** to **null**, in compliance with the SQL standard. The Transact-SQL default value for a column is **not null**, meaning that null values are not allowed in a column unless **null** is specified in the **create table** or **alter table** column definition.

auto identity

While the **auto identity** option is **true**, a 10-digit IDENTITY column is defined in each new table that is created without specifying either a **primary** key, a **unique** constraint, or an IDENTITY column. The column is not visible when you select all columns with the **select *** statement. To retrieve it, you must explicitly mention the column name, *SYB_IDENTITY_COL*, in the select list.

To set the precision of the automatic IDENTITY column, use the **size of auto identity** configuration parameter.

Though you can set **auto identity** to **true** in *tempdb*, it is not recognized or used, and temporary tables created there do not automatically include an IDENTITY column.

dbo use only

While **dbo use only** is set to **true** (on), only the Database Owner can use the database.

ddl in tran

Setting **ddl in tran** to **true** allows these commands to be used inside a user-defined transaction:

- **alter table** (clauses other than **partition** and **unpartition** are allowed)
- **create default**
- **create index**
- **create procedure**
- **create rule**
- **create schema**
- **create table**

- **create trigger**
- **create view**
- **drop default**
- **drop index**
- **drop procedure**
- **drop rule**
- **drop table**
- **drop trigger**
- **drop view**
- **grant**
- **revoke**

Data definition statements lock system tables for the duration of a transaction, which can result in performance problems. Use them only in short transactions.

These commands cannot be used in a user-defined transaction under any circumstances:

- **alter database**
- **alter table...partition**
- **alter table...unpartition**
- **create database**
- **disk init**
- **dump database**
- **dump transaction**
- **drop database**
- **load transaction**
- **load database**
- **select into**
- **truncate table**
- **update statistics**

identity in nonunique index

identity in nonunique index automatically includes an IDENTITY column in a table's index keys so that all indexes created on the table are unique. This database option makes logically nonunique indexes internally unique and allows those indexes to be used to process updatable cursors and isolation level 0 reads.

The table must already have an IDENTITY column for the **identity in nonunique index** option to work either from a **create table** statement or from setting the **auto identity** database option to **true** before creating the table.

Use **identity in nonunique index** if you plan to use cursors and isolation level 0 reads on tables that have nonunique indexes. A unique index ensures that the cursor is positioned at the correct row the next time a **fetch** is performed on that cursor.

Do not confuse the **identity in nonunique index** option with **unique auto_identity index**, which is used to add an IDENTITY column with a unique, nonclustered index to new tables.

no chkpt on recovery

no chkpt on recovery is set to **true** (on) when an up-to-date copy of a database is kept. In these situations, there is a "primary" database and a "secondary" database. Initially, the primary database is dumped and loaded into the secondary database. Then, at intervals, the transaction log of the primary database is dumped and loaded into the secondary database.

If this option is set to **false** (off)—the default—a checkpoint record is added to the database after it is recovered by restarting Adaptive Server. This checkpoint, which ensures that the recovery mechanism is not re-run unnecessarily, changes the sequence number of the database. If the sequence number of the secondary database has been changed, a subsequent dump of the transaction log from the primary database cannot be loaded into it.

Turning this option on for the secondary database causes it to not get a checkpoint from the recovery process so that subsequent transaction log dumps from the primary database can be loaded into it.

no free space acctg

no free space acctg suppresses free-space accounting and execution of threshold actions for the non-log segments. This speeds recovery time because the free-space counts will not be recomputed for those segments. It disables updating the rows-per-page value stored for each table, so system procedures that estimate space usage may report inaccurate values.

read only

read only means that users can retrieve data from the database, but cannot modify anything.

select into/bulkcopy/pllsort

select into/bulkcopy/pllsort must be set to **on** to perform operations that do not keep a complete record of the transaction in the log, which include:

- Using the **writetext** utility.
- Doing a **select into** a permanent table.
- Doing a "fast" **bulk copy** with **bcp**. By default, fast **bcp** is used on tables that do not have indexes.
- Performing a parallel sort.

Adaptive Server performs minimal logging for these commands, recording only page allocations and deallocations, but not the actual changes made to the data pages.

You do not have to set **select into/bulkcopy/pllsort on** to **select into** a temporary table, since *tempdb* is never recovered. Additionally, you do not need to set the option to run **bcp** on a table that has indexes, because inserts are logged.

After you have run **select into** or performed a bulk copy in a database, you will not be able to perform a regular transaction log dump. After you have made minimally logged changes to your database, you must perform a **dump database**, since changes are not recoverable from transaction logs.

Setting **select into/bulkcopy/pllsort** does not block log dumping, but making minimally logged changes to data does block the use of a regular **dump transaction**. However, you can still use **dump transaction...with no_log** and **dump transaction...with truncate_only.**

By default, **select into/bulkcopy/pllsort** is turned off in newly created databases. To change the default, turn this option on in the *model* database.

single user

When **single user** is set to **true**, only one user at a time can access the database. You cannot set **single user** to **true** in *tempdb*.

trunc log on chkpt

When **trunc log on chkpt** is **true** (on), the transaction log is truncated (committed transactions are removed) when the **checkpoint** checking process occurs (usually more than once per minute), if 50 or more rows have been written to the log. The log is **not** truncated if less than 50 rows were written to the log, or if the Database Owner runs the **checkpoint** command manually.

You may want to turn this option on while doing development work during which backups of the transaction log are not needed. If this option is off (the default), and the transaction log is never dumped, the transaction log continues to grow, and you may run out of space in your database.

When **trunc log on chkpt** is on, you cannot dump the transaction log because changes to your data are not recoverable from transaction log dumps. Use **dump database** instead.

By default, the **trunc log on chkpt** option is off in newly created databases. To change the default, turn this option on in the *model* database.

◆ ***WARNING!***

If you set trunc log on chkpt on in *model*, and you need to load a set of database and transaction logs into a newly created database, be sure to turn the option off in the new database.

unique auto_identity index

When the **unique auto_identity index** option is set to **true**, it adds an IDENTITY column with a unique, nonclustered index to new tables. By default, the IDENTITY column is a 10-digit numeric datatype, but

you can change this default with the **size of auto identity column** configuration parameter.

Though you can set **unique auto_identity index** to **true** in *tempdb*, it is not recognized or used, and temporary tables created there do not automatically include an IDENTITY column with a unique index.

The **unique auto_identity index** option provides a mechanism for creating tables that have an automatic IDENTITY column with a unique index that can be used with updatable cursors. The unique index on the table ensures that the cursor is positioned at the correct row after a **fetch**. (If you are using isolation level 0 reads and need to make logically nonunique indexes internally unique so that they can process updatable cursors, use the **identity in nonunique index** option.)

In some cases, the **unique auto_identity index** option can avoid the Halloween Problem for the following reasons:

- Users cannot update an IDENTITY column; hence, it cannot be used in the cursor update.
- The IDENTITY column is automatically created with a unique, nonclustered index so that it can be used for the updatable cursor scan.

For more information about the Halloween Problem, IDENTITY columns, and cursors, see the *Transact-SQL User's Guide*.

Do not confuse the **unique auto_identity index** option with the **identity in nonunique index** option, which is used to make all indexes in a table unique by including an IDENTITY column in the table's index keys.

Changing Database Options

Only a System Administrator or the Database Owner can change a user's database options by executing **sp_dboption**. Users aliased to the Database Owner cannot change database options with **sp_dboption**.

You must be using the *master* database to execute **sp_dboption**. Then, for the change to take effect, you must issue the **checkpoint** command while using the database for which the option was changed.

Remember that you cannot change any *master* database options.

To change *pubs2* to read only:

```
use master
sp_dboption pubs2, "read only", true
```

Then, run the **checkpoint** command in the database that was changed:

```
use pubs2
checkpoint
```

For the *optname* parameter of **sp_dboption**, Adaptive Server understands any unique string that is part of the option name. To set the **trunc log on chkpt** option:

```
use master
sp_dboption pubs2, trunc, true
```

If you enter an ambiguous value for *optname*, an error message is displayed. For example, two of the database options are **dbo use only** and **read only**. Using "only" for the *optname* parameter generates a message because it matches both names. The complete names that match the string supplied are printed out so that you can see how to make the *optname* more specific.

You can turn on more than one database option at a time. You cannot change database options inside a user-defined transaction.

Viewing the Options on a Database

Use **sp_helpdb** to determine the options that are set for a particular database. **sp_helpdb** lists each active option in the "status" column of its output.

The following example shows that the **read only** option is turned on in *mydb*:

```
sp_helpdb mydb
```

```
name   db_size  owner  dbid  created         status
-----  -------  -----  ----  ------------  ----------------------
mydb   2.0 MB    sa     5    Mar 05, 1999 read only

device_fragments      size    usage           free kbytes
-----------------     ------  ------------  -------------
master                2.0 MB  data and log            576

device                         segment
------------------------------ ------------------------------
master                         default
master                         logsegment
master                         system

name    attribute_class attribute  int_value char_value
        comments
------- --------------- ---------- --------- -------------------------
        -----------
pubs2   buffer manager  cache name      NULL cache for database mydb
        NULL
```

To display a summary of the options for all databases, use **sp_helpdb** without specifying a database:

```
sp_helpdb

name                 db_size         owner         dbid
   created        status
-------------------  --------------  -------------  -----
   --------------  --------------------------

mydb                   2.0 MB           sa            5
   May 10, 1997   read only

master                 3.0 MB           sa            1
   Jan 01, 1997   no options set

model                  2.0 MB           sa            3
   Jan 01, 1997   no options set

sybsystemprocs         2.0 MB           sa            4
   Mar 31, 1995   trunc log on chkpt

tempdb                 2.0 MB           sa            2
   May 04, 1998 select into/bulkcopy/pllsort
```

23 Creating and Using Segments

This chapter introduces the system procedures and commands for using segments in databases. Topics include:

See also Chapter 33, "Controlling Physical Data Placement," in the *Performance and Tuning Guide* for information about how segments can improve system performance.

What Is a Segment?

A segment is a label that points to one or more database devices. Segment names are used in **create table** and **create index** commands to place tables or indexes on specific database devices. Using segments can improve Adaptive Server performance and give the System Administrator or Database Owner increased control over the placement, size, and space usage of database objects.

You create segments within a database to describe the database devices that are allocated to the database. Each Adaptive Server database can contain up to 32 segments, including the system-defined segments (see "System-Defined Segments" on page 23-2). Before assigning segment names, you must initialize the database devices with **disk init** and then make them available to the database with **create database** or **alter database**.

System-Defined Segments

When you first create a database, Adaptive Server creates three segments in the database, as described in Table 23-1.

Table 23-1: System-defined segments

Segment	Function
system	Stores the database's system tables
logsegment	Stores the database's transaction log
default	Stores all other database objects—unless you create additional segments and store tables or indexes on the new segments by using **create table...on** *segment_name* or **create index...on** *segment_name*

If you create a database on a single database device, the *system*, *default*, and *logsegment* segments label the same device. If you use the **log on** clause to place the transaction log on a separate device, the segments resemble those shown in Figure 23-1.

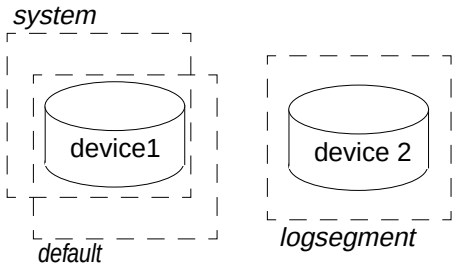


Figure 23-1: System-defined segments

Although you can add and drop user-defined segments, you cannot drop the default, system, or log segments from a database. A database must have at least one default, system-defined, and log segment.

Commands and Procedures for Managing Segments

Table 23-2 summarizes the commands and system procedures for managing segments.

Table 23-2: Commands and procedures for managing segments

Command or Procedure	Function
sp_addsegment	Defines a segment in a database.
create table and **create index**	Creates a database object on a segment.
sp_dropsegment	Removes a segment from a database or removes a single device from the scope of a segment.
sp_extendsegment	Adds devices to an existing segment.
sp_placeobject	Assigns future space allocations for a table or an index to a specific segment.
sp_helpsegment	Displays the segment allocation for a database or data on a particular segment.
sp_helpdb	Displays the segments on each database device. See Chapter 21, "Creating and Managing User Databases," for examples.
sp_help	Displays information about a table, including the segment where the table resides.
sp_helpindex	Displays information about a table's indexes, including the segments where the indexes reside.

Why Use Segments?

When you add a new device to a database, Adaptive Server places the new device in a default pool of space (the database's *default* and *system* segments). This increases the total space available to the database, but it does not determine which objects will occupy that new space. Any table or index might grow to fill the entire pool of space, leaving critical tables with no room for expansion. It is also possible for several heavily used tables and indexes to be placed on a single physical device in the default pool of space, resulting in poor I/O performance.

When you create an object on a segment, the object can use all the database devices that are available in the segment, but no other

devices. You can use segments to control the space that is available to individual objects.

The following sections describe how to use segments to control disk space usage and to improve performance. "Moving a Table to Another Device" on page 23-6 explains how to move a table from one device to another using segments and clustered indexes.

Controlling Space Usage

If you assign noncritical objects to a segment, those objects cannot grow beyond the space available in the segment's devices. Conversely, if you assign a critical table to a segment, and the segment's devices are not available to other segments, no other objects will compete with that table for space.

When the devices in a segment become full, you can extend the segment to include additional devices or device fragments as needed. Segments also allow you to use thresholds to warn you when space becomes low on a particular database segment.

If you create additional segments for data, you can create new threshold procedures for each segment. See Chapter 29, "Managing Free Space with Thresholds," for more information on thresholds.

Improving Performance

In a large, multidatabase and/or multidrive Adaptive Server environment, you can enhance system performance by paying careful attention to the allocation of space to databases and the placement of database objects on physical devices. Ideally, each database has exclusive use of database devices, that is, it does not share a physical disk with another database. In most cases, you can improve performance by placing heavily used database objects on dedicated physical disks or by "splitting" large tables across several physical disks.

The following sections describe these ways to improve performance. The *Performance and Tuning Guide* also offers more information about how segments can improve performance.

Separating Tables, Indexes, and Logs

Generally, placing a table on one physical device, its nonclustered indexes on a second physical device, and the transaction log on a

third physical device can speed performance. Using separate physical devices (disk controllers) reduces the time required to read or write to the disk. If you cannot devote entire devices in this way, at least restrict all nonclustered indexes to a dedicated physical device.

The **log on** extension to **create database** (or **sp_logdevice**) places the transaction log on a separate physical disk. Use segments to place tables and indexes on specific physical devices. See "Assigning Database Objects to Segments" on page 23-9 for information about placing tables and indexes on segments.

Splitting Tables

You can split a large, heavily used table across devices on separate disk controllers to improve the overall read performance of a table. When a large table exists on multiple devices, it is more likely that small, simultaneous reads will take place on different disks. Figure 23-2 shows a table that is split across the two devices in its segment.

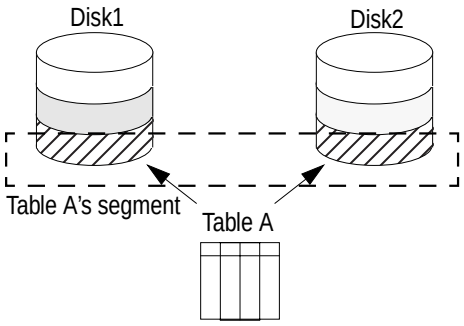


Figure 23-2: Partitioning a table across physical devices

You can split a table across devices using one of three different methods, each of which requires the use of segments:

- Use table partitioning.
- If the table has a clustered index, use partial loading.
- If the table contains *text* or *image* datatypes, separate the text chain from other data.

Partitioning Tables

Partitioning a table creates multiple page chains for the table and distributes those page chains over all the devices in the table's

segment (see Figure 23-2). Partitioning a table increases both insert and read performance, since multiple page chains are available for insertions.

Before you can partition a table, you must create the table on a segment that contains the desired number of devices. The remainder of this chapter describes how to create and modify segments. See "Commands for Partitioning Tables" in Chapter 33, "Controlling Physical Data Placement," of the *Performance and Tuning Guide* for information about partitioning tables using **alter table**.

Partial Loading

To split a table with a clustered index, use **sp_placeobject** with multiple **load** commands to load different parts of the table onto different segments. This method can be difficult to execute and maintain, but it provides a way to split tables and their clustered indexes across physical devices. See "Placing Existing Objects on Segments" on page 23-11 for more information and syntax.

Separating text and image Columns

Adaptive Server stores the data for *text* and *image* columns on a separate chain of data pages. By default, this text chain is placed on the same segment as the table's other data. Since reading a text column requires a read operation for the text pointer in the base table and an additional read operation on the text page in the separate text chain, placing the text chain and base table data on a separate physical device can improve performance. See "Placing Text Pages on a Separate Device" on page 23-14 for more information and syntax.

Moving a Table to Another Device

You can also use segments to move a table from one device to another using the **create clustered index** command. Clustered indexes, where the bottom or **leaf level** of the index contains the actual data, are on the same segment as the table. Therefore, you can completely move a table by dropping its clustered index (if one exists), and creating or re-creating a clustered index on the desired segment. See "Creating Clustered Indexes on Segments" on page 23-15 for more information and syntax.

Creating Segments

To create a segment in a database:

- Initialize the physical device with **disk init**.
- Make the database device available to the database by using the **on** clause to **create database** or **alter database**. This automatically adds the new device to the database's *default* and *system* segments.

Once the database device exists and is available to the database, define the segment in the database with the stored procedure **sp_addsegment**. The syntax is:

```
sp_addsegment segname, dbname, devname
```

where:

- *segname* is any valid identifier. Give segments names that identify what they are used for, and use extensions like "_seg."
- *dbname* is the name of the database where the segment will be created.
- *devname* is the name of the database device—the name used in **disk init** and the **create** and **alter database** statements.

This statement creates the segment *seg_mydisk1* on the database device *mydisk1*:

```
sp_addsegment seg_mydisk1, mydata, mydisk1
```

Changing the Scope of Segments

When you use segments, you also need to manage their scope – the number of database devices to which each segment points. You can:

- Extend the scope of a segment by making it point to an additional device or devices, or
- Reduce the scope of a segment by making it point to fewer devices.

Extending the Scope of Segments

You may need to extend a segment if the database object or objects assigned to the segment run out of space. **sp_extendsegment** extends the size of a segment by including additional database devices as part of an existing segment. The syntax is:

```
sp_extendsegment segname, dbname, devname
```

Before you can extend a segment:

- The database device must be listed in *sysdevices*,
- The database device must be available in the desired database, and
- The segment name must exist in the current database.

The following example adds the database device *pubs_dev2* to an existing segment named *bigseg*:

```
sp_extendsegment bigseg, pubs2, pubs_dev2
```

To extend the *default* segment in your database, you must place the word "default" in quotes:

```
sp_extendsegment "default", mydata, newdevice
```

Automatically Extending the Scope of a Segment

If you use **alter database** to add space on a database device that is new to the database, the *system* and *default* segments are extended to include the new space. Thus, the scope of the *system* and *default* segments is extended each time you add a new device to the database.

If you use **alter database** to assign additional space on an existing database device, all the segments mapped to the existing device are extended to include the new device fragment. For example, assume that you initialized a 4MB device named *newdev*, allocated 2MB of the device to *mydata*, and assigned the 2MB to the *testseg* segment:

```
alter database mydata on newdev = 2
sp_addsegment testseg, mydata, newdev
```

If you alter *mydata* later to use the remaining space on *newdev*, the remaining space fragment is automatically mapped to the *testseg* segment:

```
alter database mydata on newdev = 2
```

See "A Segment Tutorial" on page 23-19 for more examples about how Adaptive Server assigns new device fragments to segments.

Reducing the Scope of a Segment

You may need to reduce the scope of a segment if it includes database devices that you want to reserve exclusively for other segments. For example, if you add a new database device that is to be used

exclusively for one table, you will want to reduce the scope of the *default* and *system* segments so that they no longer point to the new device.

Use **sp_dropsegment** to drop a single database device from a segment, reducing the segment's scope:

```
sp_dropsegment segname, dbname, device
```

With three arguments, **sp_dropsegment** drops only the given *device* from the scope of devices spanned by the segment. You can also use **sp_dropsegment** to remove an entire segment from the database, as described under "Dropping Segments" on page 23-15.

The following example removes the database device *pubs_dev2* from the scope of *bigseg*:

```
sp_dropsegment bigseg, pubs2, pubs_dev2
```

Assigning Database Objects to Segments

This section explains how to assign new or existing database objects to user-defined segments to:

- Restrict new objects to one or more database devices
- Place a table and its index on separate devices to improve performance
- Split an existing object over multiple database devices

Creating New Objects on Segments

To place a new object on a segment, first create the new segment. You may also want to change the scope of this segment (or other segments) so that it points only to the desired database devices. Remember that when you add a new database device to a database, it is automatically added to the scope of the *default* and *system* segments.

After you have defined the segment in the current database, use **create table** or **create index** with the optional **on** *segment_name* clause to create the object on the segment. The syntax is:

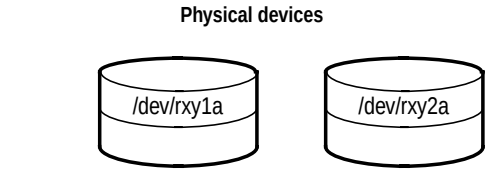
```
create table table_name (col_name datatype ... )
   [on segment_name]

create [ clustered | nonclustered ] index index_name
   on table_name(col_name)
   [on segment_name]
```

➤ ***Note***

Clustered indexes, where the bottom leaf, or leaf level, of the index contains the actual data, are by definition on the same segment as the table. See "Creating Clustered Indexes on Segments" on page 23-15.

Example: Creating a table and index on separate segments

Figure 23-3 on page 23-10 summarizes the sequence of Transact-SQL commands used to create tables and indexes on specific physical disks.



Select physical devices to be used by Adaptive Server.

1. `use master`

   Start in *master* database.

2. `disk init`
   `name = "mydisk1",`
   `physname = "/dev/rxy1a",`
   `vdevno = 7,`
   `size = 2048`

   `disk init`
   `name = "mydisk2",`
   `physname = "/dev/rxy2a",`
   `vdevno = 8,`
   `size = 1024`

   Map Adaptive Server database device name to physical device with **disk init.**

3. `alter database mydata`
   `on mydisk1 = 4, mydisk2 = 2`

   Add the devices *mydisk1* and *mydisk2* to *mydata*.

4. `use mydata`

   Change to *mydata* database.

5. `sp_addsegment seg_mydisk1, mydata, mydisk1`
   `sp_addsegment seg_mydisk2, mydata, mydisk2`

   Map segment names to database device names.

6. `sp_dropsegment "default", mydata, mydisk1`
   `sp_dropsegment system, mydata, mydisk1`
   `sp_dropsegment "default", mydata, mydisk2`
   `sp_dropsegment system, mydata, mydisk2`

   Drop devices from the scope of *system* and *default*.

7. `create table authors (au_id...) on seg_mydisk1`
   `create nonclustered index au_index on authors (au_id)`
   `on seg_mydisk2`

   Create table on one segment, and create its index on the other segment.

Figure 23-3: Creating objects on specific devices using segments

1. Start by using the *master* database.
2. Initialize the physical disks.
3. Allocate the new database devices to a database.
4. Change to the *mydata* database using the **use** *database* command.
5. Create two new segments, each of which points to one of the new devices.
6. Reduce the scope of the *default* and *system* segments so that they do not point to the new devices.
7. Create the objects, giving the new segment names.

Placing Existing Objects on Segments

sp_placeobject does not remove an object from its allocated segment. However, it causes all further disk allocation for that object to occur on the new segment it specifies. The syntax is:

sp_placeobject *segname, objname*

The following command causes all further disk allocation for the *mytab* table to take place on *bigseg*:

```
sp_placeobject bigseg, mytab
```

sp_placeobject does not move an object from one database device to another. Whatever pages have been allocated on the first device remain allocated; whatever data was written to the first device remains on the device. **sp_placeobject** affects only future space allocations.

➤ ***Note***

To completely move a table, you can drop its clustered index (if one exists), and create or re-create a clustered index on the desired segment. To completely move a nonclustered index, drop the index and re-create it on the new segment. See “Creating Clustered Indexes on Segments” on page 23-15 for instructions on moving a table.

After you have used **sp_placeobject**, executing **dbcc checkalloc** causes the following message to appear for each object that is split across segments:

```
Extent not within segment: Object object_name,
indid index_id includes extents on allocation page
page_number which is not in segment segment_name.
```

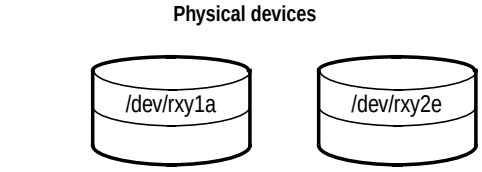
You can ignore this message.

Example: Splitting a table and its clustered index across physical devices

Performance can be improved for high-volume, multiuser applications when large tables are split across segments that are located on separate disk controllers.

The order of steps is quite important at certain stages. In particular, you must create the clustered index before you place the table is placed on the second segment.

Figure 23-4 on page 23-13 summarizes the process of splitting a table across two segments:



Select physical devices to be used by Adaptive Server.

1. **use master**

   Start in *master* database.

2. **disk init**
   name = "mydisk1",
   physname = "/dev/rxy1a",
   vdevno = 7,
   size = 2048

   disk init
   name = "mydisk2",
   physname = "/dev/rxy2e",
   vdevno = 8,
   size = 2048

   Map Adaptive Server database device name to physical device with **disk init**.

3. **alter database mydata**
   on mydisk1 = 4, mydisk2 = 4

   Add the devices *mydisk1* and *mydisk2* to *mydata*.

4. **use mydata**

   Change to *mydata* database.

5. **sp_addsegment seg_mydisk1, mydata, mydisk1**
   sp_addsegment seg_mydisk2, mydata, mydisk2
   sp_addsegment seg_bothdisks, mydata, mydisk1
   sp_extendsegment seg_bothdisks, mydata, mydisk2

   Add a segment on *mydisk1* and another on *mydisk2*. Create a third segment, and extend it to span both disks.

6. **sp_dropsegment "default", mydata, mydisk1**
   sp_dropsegment system, mydata, mydisk1
   sp_dropsegment "default", mydata, mydisk2
   sp_dropsegment system, mydata, mydisk2

   Drop devices from the scope of *system* and *default*.

7. **create table authors (au_id etc.) on seg_mydisk1**
   create clustered index au_ind on authors (au_id)
   on seg_mydisk1

   Create the table and clustered index on the segment.

8. [use **bcp** to load half of the rows]

   Load half of the rows.

9. **sp_placeobject segmydisk2, authors**

   Place the object on the second segment.

10. [use **bcp** to load the rest of the rows]

    Load the rest of the rows.

11. **sp_placeobject seg_bothdisks, authors**

    Place the table on the segment that spans both disks.

Figure 23-4: Splitting a large table across two segments

1. Begin by using the *master* database.
2. Initialize the devices with **disk init**.
3. Assign both devices to the *mydata* database with **alter database**.

4. Change to the *mydata* database by entering the **use** *database* command.
5. Create three segments. The first two should each point to one of the new devices. Extend the scope of the third segment so that it labels both devices.
6. Drop the *system* and *default* segments from both devices.
7. Create the table and its clustered index on the first segment.
8. Load half of the table's data onto the first segment.
9. Use **sp_placeobject** to cause all further allocations of disk space to occur on the second segment.
10. Load the remaining data onto the second segment.
11. Use **sp_placeobject** again to place the table on the segment that spans both devices.

The balance of disk allocation may change over time if the table is updated frequently. To guarantee that the speed advantages are maintained, you may need to drop and re-create the table at some point.

Placing Text Pages on a Separate Device

When you create a table with *text* or *image* columns, the data is stored on a separate chain of text pages. A table with *text* or *image* columns has an additional entry in *sysindexes* for the text chain, with the name column set to the name of the table preceded by the letter "t" and an *indid* of 255. You can use **sp_placeobject** to store the text chain on a separate device, giving both the table name and the name of the text chain from *sysindexes*:

```
sp_placeobject textseg, "mytab.tmytab"
```

➤ ***Note***

By default, a chain of text pages is placed on the same segment as its table. After you execute **sp_placeobject**, pages that were previously written on the old device remain allocated, but all new allocations take place on the new segment.

Creating Clustered Indexes on Segments

The bottom, or leaf level, of a clustered index contains the data. Therefore, a table and its clustered index are on the same segment. If you create a table on one segment and its clustered index on a different segment, the table will migrate to the segment where you created the clustered index. This provides a quick and easy way to move a table to other devices in your database.

The syntax for creating a clustered index on a segment is:

```
create [unique] clustered index index_name
   on [[database.]owner.]table_name (column_name
        [, column_name]...)
   [with {fillfactor = x, ignore_dup_key, sorted_data,
     [ignore_dup_row | allow_dup_row]}]
   on segment_name
```

See “Segments and Clustered Indexes” on page 23-23 for an example of this command.

Dropping Segments

When you use **sp_dropsegment** with only a segment name and the database name, the named segment is dropped from the database. However, you cannot drop a segment as long as database objects are still assigned to it. You must assign the objects to another segment or drop the objects first and then drop the segment.

The syntax for dropping a segment is:

```
sp_dropsegment segname, dbname
```

You cannot completely drop the default, system, or log segment from a database. A database must have at least one default, system, and log segment. You can, however, reduce the scope of these segments – see “Reducing the Scope of a Segment” on page 23-8.

➤ ***Note***

Dropping a segment removes its name from the list of segments in the database, but it does not remove database devices from the allocation for that database, nor does it remove objects from devices.

If you drop all segments from a database device, the space is still allocated to the database but cannot be used for database objects. **dbcc checkcatalog** reports "Missing segment in Sysusages segmap." To make a device available to a database, use **sp_extendsegment** to map the device to the database's default segment:

sp_extendsegment "default", *dbname, devname*

Getting Information About Segments

Four system procedures provide information about segments:

- **sp_helpsegment** lists the segments in a database or displays information about a particular segment in the database.
- **sp_helpdb** displays information about the relationship between devices and segments in a database.
- **sp_help** and **sp_helpindex** display information about tables and indexes, including the segment to which the object is assigned.

sp_helpsegment

sp_helpsegment, when used without an argument, displays information about all of the segments in the database where you execute it:

```
sp_helpsegment
segment name                          status
------- ----------------------------- ------
      0 system                             0
      1 default                            1
      2 logsegment                         0
      3 seg1                               0
      4 seg2                               0
```

For information about a particular segment, specify the segment name as an argument. Use quotes when requesting information about the *default* segment:

```
sp_helpsegment "default"
```

The following example displays information about *seg1*:

```
sp_helpsegment seg1
segment name                          status
------- ------------------------------ ------
      4 seg1                              0

device                 size             free_pages
---------------------- ---------------- -----------
user_data10            15.0MB                 6440
user_data11            15.0MB                 6440
user_data12            15.0MB                 6440

table_name             index_name            indid
---------------------- ---------------------- ------
customer               customer                   0

total_size      total_pages free_pages  used_pages
--------------- ----------- ----------- -----------
45.0MB                23040       19320        3720
```

sp_helpdb

When you execute **sp_helpdb** within a database, and give that database's name, you see information about the segments in the database.

For example:

```
sp_helpdb mydata
```

```
name      db_size    owner  dbid created        status
--------- ---------- ----------- -------------- ------------
mydata        8.0 MB sa        4 May 27, 1993   no options set

device_fragments    size       usage             free kbytes
------------------- ---------- ----------------- -----------
datadev2            4.0 MB     data only                3408
logdev              2.0 MB     log only                 2032
seg_mydisk1         2.0 MB     data only                2016

device                         segment
------------------------------ -------------------------
datadev2                       default
datadev2                       system
logdev                         logsegment
seg_mydisk1                    seg1
```

sp_help and *sp_helpindex*

When you execute **sp_help** and **sp_helpindex** in a database, and give a table's name, you see information about which segment(s) stores the table or its indexes.

For example:

```
sp_helpindex authors
index_name     index_description                    index_keys
------------   ---------------------------------    ----------
au_index       nonclustered located on seg_mydisk2  au_id
```

Segments and System Tables

Three system tables store information about segments: *master..sysusages* and two system tables in the user database, *sysindexes* and *syssegments*. **sp_helpsegment** uses these tables. Additionally, it finds the database device name in *sysdevices*.

When you allocate a device to a database with **create database** or **alter database**, Adaptive Server adds a row to *master..sysusages*. The *segmap* column in *sysusages* provides bitmaps to the segments in the database for each device.

create database also creates the *syssegments* table in the user database with these default entries:

```
segment name            status
------- --------------- ------
      0 system              0
      1 default             1
      2 logsegment          0
```

When you add a segment to a database with **sp_addsegment**, the procedure:

- Adds a new row to the *syssegments* table in the user database, and
- Updates the *segmap* in *master..sysusages*.

When you create a table or an index, Adaptive Server adds a new row to *sysindexes*. The *segment* column in that table stores the segment number, showing where the server will allocate new space for the object. If you do not specify a segment name when you create the object, it is placed on the *default* segment; otherwise, it is placed on the specified segment.

If you create a table containing *text* or *image* columns, a second row is also added to *sysindexes* for the linked list of text pages; by default,

the chain of text pages is stored on the same segment as the table. An example using **sp_placeobject** to put the text chain on its own segment is included under "A Segment Tutorial" on page 23-19.

The *name* from *syssegments* is used in **create table** and **create index** statements. The *status* column indicates which segment is the default segment.

➤ ***Note***

See "System Tables That Manage Space Allocation" on page 21-14 for more information about the *segmap* column and the system tables that manage storage.

A Segment Tutorial

The following tutorial shows how to create a user segment and how to remove all other segment mappings from the device.

When you are working with segments and devices, remember that:

- If you assign space in fragments, each fragment will have an entry in *sysusages*.
- When you assign an additional fragment of a device to a database, all segments mapped to the existing fragment are mapped to the new fragment.
- If you use **alter database** to add space on a device that is new to the database, the *system* and *default* segments are automatically mapped to the new space.

The tutorial begins with a new database, created with one device for the database objects and another for the transaction log:

```
create database mydata on bigdevice = 4
     log on logdev = 2
```

Now, if you **use mydata**, and run **sp_helpdb**, you see:

```
sp_helpdb mydata
```

```
name       db_size  owner     dbid   created      status
---------- -------- --------- ------ ------------ ---------------
mydata       6.0 MB sa             4 May 27, 1993  no options set

device_fragments       size          usage           free kbytes
---------------------- ------------- --------------- -----------
bigdevice              4.0 MB        data only              3408
logdev                 2.0 MB        log only               2032

device                 segment
---------------------- ----------------------
bigdevice              default
bigdevice              system
logdev                 logsegment
```

Like all newly created databases, *mydata* has the segments named *default*, *system*, and *logsegment*. Because **create database** used **log on**, the *logsegment* is mapped to its own device, *logdev*, and the *default* and *system* segments are both mapped to *bigdevice*.

If you add space on the same database devices to *mydata*, and run **sp_helpdb** again, you see entries for the added fragments:

```
use master

alter database mydata on bigdevice = 2
    log on logdev = 1

use mydata

sp_helpdb mydata
```

```
name       db_size  owner     dbid   created      status
---------- -------- --------- ------ ------------ ---------------
mydata       9.0 MB sa             4 May 27, 1993  no options set

device_fragments       size          usage           free kbytes
---------------------- ------------- --------------- -----------
bigdevice              2.0 MB        data only              2048
bigdevice              4.0 MB        data only              3408
logdev                 1.0 MB        log only               1024
logdev                 2.0 MB        log only               2032

device                 segment
---------------------- ----------------------
bigdevice              default
bigdevice              system
logdev                 logsegment
```

Always add log space to log space and data space to data space. Adaptive Server instructs you to use **with override** if you try to allocate

a segment that is already in use for data to the log, or vice versa. Remember that segments are mapped to entire devices, and not just to the space fragments. If you change any of the segment assignments on a device, you make the change for all of the fragments.

The following example allocates a new database device that has not been used by *mydata*:

```
use master
alter database mydata on newdevice = 3
use mydata
sp_helpdb mydata
```

```
name       db_size  owner     dbid   created      status
---------- -------- --------- ------ ------------ ---------------
mydata      12.0 MB sa             4 May 27, 1993  no options set

device_fragments       size          usage           free kbytes
---------------------- ------------- --------------- -----------
bigdevice              2.0 MB        data only              2048
bigdevice              4.0 MB        data only              3408
logdev                 1.0 MB        log only               1024
logdev                 2.0 MB        log only               2032
newdevice              3.0 MB        data only              3072

device                 segment
---------------------- ----------------------
bigdevice              default
bigdevice              system
logdev                 logsegment
newdevice              default
newdevice              system
```

The following example creates a segment called *new_space* on *newdevice*:

```
sp_addsegment new_space, mydata, newdevice
```

Here is the portion of the **sp_helpdb** report which lists the segment mapping:

```
device                          segment
------------------------------ ------------------
bigdevice                       default
bigdevice                       system
logdev                          logsegment
newdevice                       default
newdevice                       new_space
newdevice                       system
```

The *default* and *system* segments are still mapped to *newdevice*. If you are planning to use *new_space* to store a user table or index for improved performance, and you want to ensure that other user objects are not stored on the device by default, reduce the scope of *default* and *system* with **sp_dropsegment**:

```
sp_dropsegment system, mydata, newdevice
sp_dropsegment "default", mydata, newdevice
```

You must include the quotes around "default;" it is a Transact-SQL reserved word.

Here is the portion of the **sp_helpdb** report that shows the segment mapping:

```
device                          segment
------------------------------ --------------------
bigdevice                       default
bigdevice                       system
logdev                          logsegment
newdevice                       new_space
```

Only *new_space* is now mapped to *newdevice*. Users who create objects can use **on** *new_space* to place a table or index on the device that corresponds to that segment. Since the *default* segment is not pointing to that database device, users who create tables and indexes without using the **on** clause will not be placing them on your specially prepared device.

If you use **alter database** on *newdevice* again, the new space fragment acquires the same segment mapping as the existing fragment of that device (that is, the *new_space* segment only).

At this point, if you use **create table** and name *new_space* as the segment, you will get results like these from **sp_help** and **sp_helpsegment**:

```
create table mytabl (c1 int, c2 datetime)
    on new_space
sp_help mytabl
```

```
Name              Owner             Type
----------------- ----------------- ----------------
mytabl            dbo               user table

Data_located_on_segment        When_created
------------------------------ --------------------
new_space                      May 27 1993  3:21PM

Column_name   Type      Length Nulls Default_name Rule_name
------------- --------- ------ ----- ------------ ----------
c1            int            4     0 NULL         NULL
c2            datetime       8     0 NULL         NULL
Object does not have any indexes.
No defined keys for this object.
```

```
sp_helpsegment new_space
segment name                          status
------- ------------------------------ ------
      3 new_space                           0

device                 size           free_pages
---------------------- -------------- -----------
newdevice              3.0MB                1528

table_name            index_name             indid
--------------------- ---------------------- ------
mytabl                mytabl                      0

total_size       total_pages free_pages  used_pages
---------------- ----------- ----------- -----------
3.0MB                  1536        1528           8
```

Segments and Clustered Indexes

This example creates a clustered index, without specifying the segment name, using the same table you just created on the *new_space* segment in the preceding example. Check *new_space* after **create index** to verify that no objects remain on the segment:

```
/* Don't try this at home */
create clustered index mytabl_cix
    on mytabl(c1)

sp_helpsegment new_space
```

```
segment name                          status
------- ------------------------------ ------
      3 new_space                           0

device                 size           free_pages
---------------------- -------------- -----------
newdevice              3.0MB                 1528

total_size       total_pages free_pages  used_pages
---------------- ----------- ----------- -----------
3.0MB                   1536        1528           8
```

If you have placed a table on a segment, and you need to create a clustered index, use the **on** *segment_name* clause, or the table will migrate to the *default* segment.

24 Using the *reorg* Command

Update activity against a table can eventually lead to inefficient utilization of space and reduced performance. The **reorg** command reorganizes the use of table space and improves performance.

This chapter discusses:

reorg Subcommands

The **reorg** command provides four subcommands for carrying out different types and levels of reorganization:

- **reorg forwarded_rows** undoes row forwarding.
- **reorg reclaim_space** reclaims unused space left on a page as a result of deletions and row-shortening updates.
- **reorg compact** both reclaims space and undoes row forwarding.
- **reorg rebuild** undoes row forwarding and reclaims unused page space, as does **reorg compact.** In addition, **reorg rebuild**:
  - Rewrites all rows to accord with a table's clustered index, if it has one
  - Writes rows to data pages to accord with any changes made in space management settings through **sp_chgattribute**
  - Drops and re-creates all indexes belonging to the table

The **reclaim_space**, **forwarded_rows**, and **compact** subcommands:

- Minimize interference with other activities by using multiple small transactions of brief duration. Each transaction is limited to eight pages of **reorg** processing.
- Provide **resume** and **time** options that allow you to set a time limit on how long a **reorg** runs and to resume a **reorg** from the point at which the previous **reorg** stopped. This allows you to, for example, use a series of partial reorganizations at off-peak times to **reorg** a large table. For more information, see "resume and time Options for Reorganizing Large Tables" on page 24-7.

The following considerations apply to the **rebuild** subcommand:

- **reorg rebuild** holds an exclusive table lock for its entire duration. On a large table this may be a significant amount of time. However, **reorg rebuild** accomplishes everything that dropping and re-creating a clustered index does and takes less time. In addition, **reorg rebuild** rebuilds the table using all of the table's current space management settings. Dropping and re-creating an index does not use the space management setting for **reservepagegap**.
- In most cases, **reorg rebuild** requires additional disk space equal to the size of the table it is rebuilding and its indexes.

The following restrictions hold:

- The table specified in the command, if any, must use either the **datarows** or **datapages** locking scheme.
- You must be a System Administrator or the object owner to issue **reorg**.
- You cannot issue **reorg** within a transaction.

When to Run a *reorg* Command

reorg is useful when:

- A large number of forwarded rows causes extra I/O during read operations.
- Inserts and serializable reads are slow because they encounter pages with noncontiguous free space that needs to be reclaimed.
- Large I/O operations are slow because of low cluster ratios for data and index pages.
- **sp_chgattribute** was used to change a space management setting (**reservepagegap**, **fillfactor**, or **exp_row_size**) and the change is to be

applied to all existing rows and pages in a table, not just to future updates.

Using the *optdiag* Utility to Assess the Need for a *reorg*

To assess the need for running a **reorg**, you can use statistics from the *systabstats* table and the **optdiag** utility. *systabstats* contains statistics on the utilization of table space, while **optdiag** generates reports based on statistics in both *systabstats* and the *sysstatistics* table.

For information on the *systabstats* table, see the *Performance and Tuning Guide*. For information about **optdiag**, see *Utility Programs for UNIX Platforms*.

Space Reclamation Without the *reorg* Command

Several types of activities reclaim or reorganize the use of space in a table on a page-by-page basis:

- Inserts, when an insert encounters a page that would have enough room if it reclaimed unused space.
- The **update statistics** command (for index pages only)
- Re-creating clustered indexes
- The housekeeper task, if **enable housekeeper GC** is set to **1**

Each of these has limitations and may be insufficient for use on a large number of pages. For example, inserts may execute more slowly when they need to reclaim space, and may not affect many pages with space that can be reorganized. Space reclamation under the housekeeper task compacts unused space, but it runs only when no other tasks are requesting CPU time, so it may not reach every page that needs it.

Moving Forwarded Rows to Home Pages

If an update makes a row too long to fit on its current page, the row is forwarded to another page. A reference to the row is maintained on its original page, the row's **home** page, and all access to the forwarded row goes through this reference. Thus, it always takes two page accesses to get to a forwarded row. If a scan needs to read a large number of forwarded pages, the I/Os caused by extra page accesses slow performance.

reorg forwarded_rows undoes row forwarding by either moving a forwarded row back to its home page, if there is enough space, or by deleting the row and reinserting it in a new home page.

You can get statistics on the number of forwarded rows in a table by querying *systabstats* and using **optdiag.**

reorg forwarded_rows Syntax

The syntax for **reorg forwarded_rows** is:

```
reorg forwarded_rows tablename
   [with {resume, time = no_of_minutes}]
```

For information about the **resume** and **time** options, see "resume and time Options for Reorganizing Large Tables" on page 24-7.

reorg forwarded_rows does not apply to indexes, because indexes do not have forwarded rows.

Using *reorg compact* to Remove Row Forwarding

reorg forwarded_rows uses allocation page hints to find forwarded rows. Because it does not have to search an entire table, this comand executes quickly, but it may miss some forwarded rows. After running **reorg forwarded_rows**, you can evaluate its effectiveness by using **optdiag** and checking "Forwarded row count." If "Forwarded row count" is high, you can then run **reorg compact**, which goes through a table page by page and undoes all row forwarding.

Reclaiming Unused Space from Deletes and Updates

When a task performs a delete operation or an update that shortens row length, the empty space is preserved in case the transaction is rolled back. If a table is subject to frequent deletes and row-shortening updates, unreclaimed space may accumulate to the point that it impairs performance.

reorg reclaim_space reclaims unused space left by deletes and updates. On each page that has space resulting from committed deletes or row-shortening updates, **reorg reclaim_space** rewrites the remaining rows contiguously, leaving all the unused space at the end of the page. If all rows have been deleted and there are no remaining rows, **reorg reclaim_space** deallocates the page.

You can get statistics on the number of unreclaimed row deletions in a table from the *systabstats* table and by using the **optdiag** utility. There

is no direct measure of how much unused space there is as a result of row-shortening updates.

reorg reclaim_space Syntax

The syntax for **reorg reclaim_space** is:

```
reorg reclaim_space tablename [indexname]
   [with {resume, time = no_of_minutes}]
```

If you specify only a table name, only the table's data pages are reorganized to reclaim unused space; in other words, indexes are not affected. If you specify an index name, only the pages of the index are reorganized.

For information about the **resume** and **time** options, see "resume and time Options for Reorganizing Large Tables" on page 24-7.

Reclaiming Unused Space and Undoing Row Forwarding

reorg compact combines the functions of **reorg reclaim_space** and **reorg forwarded_rows**. Use **reorg compact** when:

- You don't need to rebuild an entire table (**reorg rebuild**); however, both row forwarding and unused space from deletes and updates may be affecting performance.
- There are a large number of forwarded rows. See "Using reorg compact to Remove Row Forwarding" on page 24-4.

reorg compact Syntax

The syntax for **reorg compact** is:

```
reorg compact tablename
   [with {resume, time = no_of_minutes}]
```

For information about the **resume** and **time** options, see "resume and time Options for Reorganizing Large Tables" on page 24-7.

Rebuilding a Table

Use **reorg rebuild** when:

- Large I/O is not being selected for queries where it is usually used, and **optdiag** shows a low cluster ratio for datapages, data rows, or index pages.

- You used **sp_chgattribute** to change one or more of the **exp_row_size**, **reservepagegap**, or **fillfactor** space management settings and you want the changes to apply not only to future data, but also to existing rows and pages. For information about **sp_chgattribute**, see the *Adaptive Server Reference Manual*.

If a table needs to be rebuilt because of a low cluster ratio, it may also need to have its space management settings changed (see "Changing Space Management Settings Before Using reorg rebuild" on page 24-7).

reorg rebuild uses a table's current space management settings to rewrite the rows in the table according to the table's clustered index, if it has one. All indexes on the table are dropped and re-created using the current space management values for **reservepagegap** and **fillfactor**. After a **rebuild**, a table has no forwarded rows and no unused space from deletions or updates.

reorg rebuild Syntax

The syntax for **reorg rebuild** is:

```
reorg rebuild tablename
```

Prerequisites for Running *reorg rebuild*

Before you run **reorg rebuild** on a table:

- Set the database option **select into/bulkcopy/pllsort** to **true** and run **checkpoint** in the database.
- Make sure that additional disk space, equal to the size of the table and its indexes, is available.

To set **select into/bulkcopy/pllsort** to **true** and checkpoint the database, use the following **isql** commands:

```
1> use master
2> go
1> sp_dboption pubs2,
    "select into/bulkcopy/pllsort", true
2> go
1> use pubs2
2> go
1> checkpoint
2> go
```

Following a **rebuild** on a table:

- You must dump the database containing the table before you can dump the transaction log.
- Distribution statistics for the table are updated.
- All stored procedures that reference the table will be recompiled the next time they are run.

Changing Space Management Settings Before Using *reorg rebuild*

When **reorg rebuild** rebuilds a table, it rewrites all table and index rows according to the table's current settings for **reservepagegap**, **fillfactor**, and **exp_row_size**. These properties all affect how quickly inserts cause a table to become fragmented, as measured by a low cluster ratio.

If it appears that a table quickly becomes fragmented and needs to be rebuilt too frequently, it may be a sign that you need to change the table's space management settings before you run **reorg rebuild**.

To change the space management settings, use **sp_chgattribute** (see the *Adaptive Server Reference Manual*). For information on space management settings, see *Performance and Tuning Guide*

resume and *time* Options for Reorganizing Large Tables

Use the **resume** and **time** options of the **reorg** command when reorganizing an entire table would take too long and interfere with other database activities. **time** allows you to run a **reorg** for a specified length of time. **resume** allows you to start a **reorg** at the point in a table where the previous **reorg** left off. In combination, the two options allow you to reorganize a large table by running a series of partial reorganizations (for example, during off-hours).

resume and **time** not available with **reorg rebuild**.

Syntax for Using *resume* and *time* in *reorg* Commands

The syntax for **resume** and **time** is:

```
reorg reclaim_space tablename [indexname]
   [with {resume, time = no_of_minutes}]
reorg forwarded_rows tablename
   [with {resume, time = no_of_minutes}]
reorg compact tablename
   [with {resume, time = no_of_minutes}]
```

The following considerations apply:

- If you specify only the **resume** option, the **reorg** begins at the point where the previous **reorg** stopped and continues to the end of the table.
- If you specify only the **time** option, the **reorg** starts at the beginning of the table and continues for the specified number of minutes.
- If you specify both options, the **reorg** starts at the point where the previous **reorg** stopped and continues for the specified number of minutes.

Specifying *no_of_minutes* in the *time* Option

The *no_of_minutes* argument in the **time** option refers to elapsed time, not CPU time. For example, to run **reorg compact** for 30 minutes, beginning where a previous **reorg compact** finished, enter:

```
reorg compact tablename with resume, time=30
```

If the **reorg** process goes to sleep during any part of the 30 minutes, it still counts as part of the elapsed time and does not add to the duration of the **reorg**.

When the amount of time specified has passed, **reorg** saves statistics about the portion of the table or index that was processed in the *systabstats* table. This information is used as the restart point for a **reorg** with the **resume** option. The restart points for each of the three subcommands that take **resume** and **time** options are maintained separately. You cannot, for example, start a reorg with **reorg reclaim_space** and then resume it with **reorg compact**.

If you specify *no_of_minutes*, and **reorg** arrives at the end of a table or an index before the time is up, it returns to the beginning of the object and continues until it reaches its time limit.

➤ ***Note***

resume and **time** allow you to reorganize an entire table or index over multiple runs. However, if there are updates between **reorg** runs, some pages may be processed twice and some pages may not be processed at all.

Using the *reorg rebuild* Command on Indexes

Adaptive Server 12.x extends the functionality of the **reorg rebuild** command, allowing you to rebuild individual indexes while the table itself is accessible for read and update activities.

Syntax

The syntax for rebuilding an index is:

```
reorg rebuild indexname
```

Comments

To use **reorg rebuild**, you must be the table owner or the Database Owner, or have System Administrator privileges.

If you omit the index name, the entire table is rebuilt.

If you specify an index, only that index is rebuilt.

Requirements for using **reorg rebuild** on an index are less stringent than for tables. The following rules apply:

- You do not need to set **select into** to rebuild an index.
- Rebuilding a table requires space for a complete copy of the table. Rebuilding an index works in small transactions, and deallocates pages once they are copied; therefore, the process only needs space for the pages copied on each transaction.
- You can rebuild the index on a table while transaction level scans (dirty reads) are active.

Limitations

The **reorg** command applies only to tables using datarows or datapages locking. You cannot run **reorg** on a table that uses allpages locking.

You cannot run **reorg** on a text index, the name from *sysindexes* associated with a text chain.

You cannot run **reorg** within a transaction.

You can do a **dump tran** on a table after rebuilding its index. However, you cannot do a **dump tran** if the entire table has been rebuilt.

You can rebuild the index for *systabstats*, but you cannot run **reorg rebuild** on the table itself.

Although online index rebuilding is allowed on a placement index, it rebuilds only the index pages. The data pages remain untouched, which means datarows are neither sorted nor rewritten to fresh pages. You can rebuild data pages by dropping a placement index, and then re-creating it.

How Indexes are Rebuilt with *reorg rebuild indexname*

Rebuilding a single index rewrites all index rows to new pages. This improves performance by:

- Improving clustering of the leaf level of the index
- Applying stored values for the fill factor on the index, which can reduce page splits
- Applying any stored value for *reservepagegap*, which can help reserve pages for future splits

To reduce contention with users whose queries need to use the index, **reorg rebuild** locks a small number of pages at a time. Rebuilding an index is a series of independent transactions, with some independent, nested transactions. Approximately 32 pages are rebuilt in each nested transaction and approximately 256 pages are rebuilt in each outer transaction. Address locks are acquired on the pages being modified and are released at the end of the topaction. The pages deallocated in a transaction are not available for reuse until the next transaction begins.

If the **reorg rebuild** command stops running, the transactions that are already committed are not rolled back. Therefore, the part that has been reorganized is well clustered with desired space utilization, and the part that has not been reorganized is the same as it was before you ran the command. The index remains logically consistent.

➤ ***Note***

Rebuilding the clustered index does not affect the data pages of the table. It only affects the leaf pages and higher index levels. Non-leaf pages above level 1 are not rebuilt.

Space Requirements for Rebuilding an Index

If you do not specify **fill_factor** or **reservepagegap**, rebuilding an index requires additional space of aproximately 256 pages or less in the data segment. The amount of log space required is larger than that required to drop the index and re-create it using **create index**, but it should be only a small fraction of the actual index size. The more additional free space is available, the better the index clustering will be.

➤ ***Note***

reorg rebuild may not rebuild those parts of the index that are already well clustered and have the desired space utilization.

Performance Characteristics

Index scans are faster after you run **reorg**.

Running **reorg** against a table can have a negative effect on performance of concurrent queries.

Status Messages

Running **reorg rebuild** ***indexname*** on a large table may take a long time. Periodic status messages are printed to give the user an idea of how **reorg** has progressed. Starting and ending messages are written to the error log and to the client process executing **reorg**. In-progress messages go only to the client.

A status reporting interval is calculated as either 10% of the pages to be processed or 10,000 pages, whichever is larger. When this number of pages is processed, a status message is printed. Therefore, no more than 10 messages are printed, regardless of the size of the index. Status messages for existing **reorg** commands are printed more frequently.

25 Checking Database Consistency

This chapter describes how to check database consistency and perform some kinds of database maintenance using the **dbcc** commands. Topics include:

What Is the Database Consistency Checker?

The database consistency checker (**dbcc**) provides commands for checking the logical and physical consistency of a database. Two major functions of **dbcc** are:

- Checking page linkage and data pointers at both the page level and the row level using **checkstorage** or **checktable** and **checkdb**
- Checking page allocation using **checkstorage**, **checkalloc**, or **checkverify**, **tablealloc**, and **indexalloc**

dbcc checkstorage stores the results of checks in the *dbccdb* database. You can print reports from *dbccdb* using the **dbcc** stored procedures.

Use the **dbcc** commands:

- As part of regular database maintenance – the integrity of the internal structures of a database depends upon the System Administrator or Database Owner running database consistency checks on a regular basis.
- To determine the extent of possible damage after a system error has occurred.
- Before backing up a database for additional confidence in the integrity of the backup.
- If you suspect that a database is damaged – for example, if using a particular table generates the message "Table corrupt," you can use **dbcc** to determine if other tables in the database are also damaged.

If you are using Component Integration Services, there are additional **dbcc** commands you can use for remote databases. For more information, see the *Component Integration Services User's Guide*.

Understanding Page and Object Allocation Concepts

When you initialize a database device, the **disk init** command divides the new space into **allocation units** of 256 2K data pages. The first page of each allocation unit is an **allocation page**, which tracks the use of all pages in the allocation unit. Allocation pages have an object ID of 99; they are not real database objects and do not appear in system tables, but **dbcc** errors on allocation pages report this value.

When a table or an index requires space, Adaptive Server allocates a block of 8 2K pages to the object. This 8-page block is called an **extent**. Each 256-page allocation unit contains 32 extents. Adaptive Server uses extents as a unit of space management to allocate and deallocate space as follows:

- When you create a table or an index, Adaptive Server allocates an extent for the object.
- When you add rows to an existing table, and the existing pages are full, Adaptive Server allocates another page. If all pages in an extent are full, Adaptive Server allocates an additional extent.
- When you drop a table or an index, Adaptive Server deallocates the extents it occupied.

- When you delete rows from a table so that it shrinks by a page, Adaptive Server deallocates the page. If the table shrinks off the extent, Adaptive Server deallocates the extent.

Every time space is allocated or deallocated on an extent, Adaptive Server records the event on the allocation page that tracks the extents for that object. This provides a fast method for tracking space allocations in the database, since objects can shrink or grow without excess overhead.

Figure 25-1 shows how data pages are set up within extents and allocation units in Adaptive Server databases.

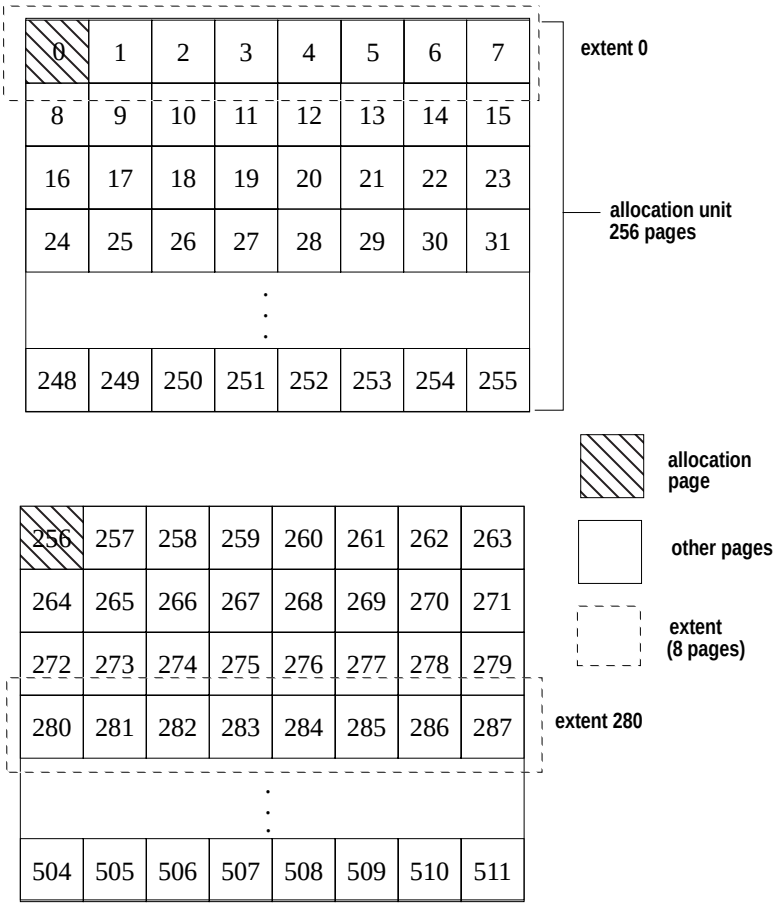


Figure 25-1: Page management with extents

dbcc checkalloc checks all allocation pages (page 0 and all pages divisible by 256) in a database and reports on the information it finds. **dbcc indexalloc** and **dbcc tablealloc** check allocation for specific database objects.

Understanding the Object Allocation Map (OAM)

Each table and index on a table has an **Object Allocation Map** (**OAM**). The OAM is stored on pages allocated to the table or index and is checked when a new page is needed for the index or table. A single OAM page can hold allocation mapping for between 2,000 and 63,750 data or index pages.

The OAM pages point to the allocation page for each allocation unit where the object uses space. The allocation pages, in turn, track the information about extent and page usage within the allocation unit. In other words, if the *titles* table is stored on extents 24 and 272, the OAM page for the *titles* table points to pages 0 and 256.

Figure 25-2 shows an object stored on 4 extents, numbered 0, 24, 272 and 504. The OAM is stored on the first page of the first segment. In this case, since the allocation page occupies page 0, the OAM is located on page 1.

This OAM points to two allocation pages: page 0 and page 256.

These allocation pages track the pages used in each extent used by all objects with storage space in the allocation unit. For the object in this example, it tracks the allocation and de-allocation of pages on extents 0, 24, 272, and 504.

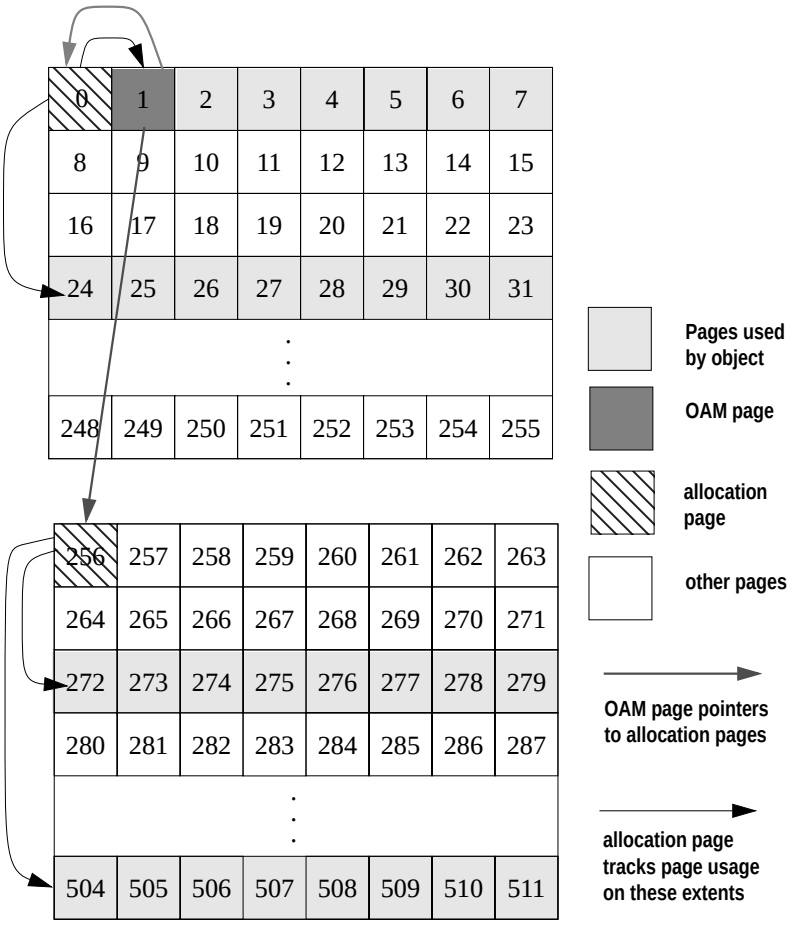


Figure 25-2: OAM page and allocation page pointers

dbcc checkalloc and **dbcc tablealloc** examine this OAM page information, in addition to checking page linkage, as described in "Understanding Page Linkage" on page 25-6.

Understanding Page Linkage

After a page has been allocated to a table or an index, that page is linked with other pages used for the same object. Figure 25-3

illustrates this linking. Each page contains a header that includes the number of the page that precedes it ("prev") and of the page that follows it ("next"). When a new page is allocated, the header information on the surrounding pages changes to point to that page. **dbcc checktable** and **dbcc checkdb** check page linkage. **dbcc checkalloc**, **tablealloc**, and **indexalloc** compare page linkage to information on the allocation page.

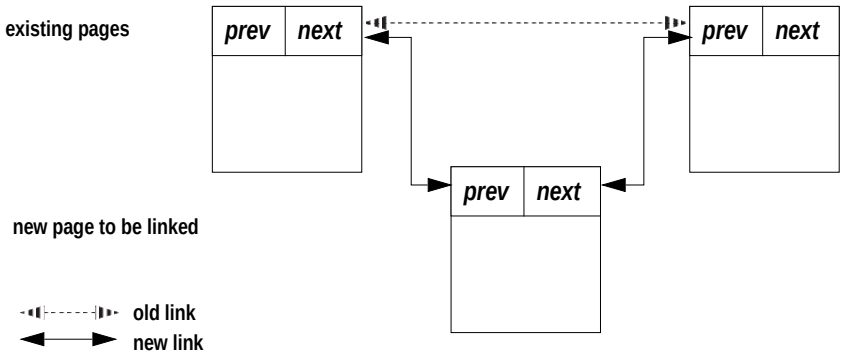


Figure 25-3: How a newly allocated page is linked with other pages

What Checks Can Be Performed with *dbcc*?

Table 25-1 summarizes the checks performed by the **dbcc** commands. Table 25-2 on page 25-20 compares the different **dbcc** commands.

Table 25-1: Comparison of checks performed by *dbcc* commands

Checks Performed	*check-storage*	*check-table*	*check-db*	*check-alloc*	*index-alloc*	*table-alloc*	*check-catalog*
Checks allocation of text valued columns	X						
Checks index consistency		X	X				
Checks index sort order		X	X				
Checks OAM page entries	X	X	X		X	X	
Checks page allocation	X			X	X	X	
Checks page consistency	X	X	X				

Table 25-1: Comparison of checks performed by *dbcc* commands (continued)

Checks Performed	*check-storage*	*check-table*	*check-db*	*check-alloc*	*index-alloc*	*table-alloc*	*check-catalog*
Checks pointer consistency	X	X	X				
Checks system tables							X
Checks text column chains	X	X	X	X			
Checks text valued columns	X	X	X				

➤ ***Note***

You can run all **dbcc** commands except **dbrepair** and **checkdb** with the **fix** option while the database is active.

Only the table owner can execute **dbcc** with the **checktable**, **fix_text**, or **reindex** keywords. Only the Database Owner can use the **checkstorage**, **checkdb**, **checkcatalog**, **checkalloc**, **indexalloc**, and **tablealloc** keywords. Only a System Administrator can use the **dbrepair** keyword.

Checking Consistency of Databases and Tables

The **dbcc** commands for checking the consistency of databases and tables are:

- **dbcc checkstorage**
- **dbcc checktable**
- **dbcc checkdb**

dbcc checkstorage

Use **dbcc checkstorage** to perform the following checks:

- Allocation of text valued columns
- Page allocation and consistency
- OAM page entries
- Pointer consistency
- Text valued columns and text column chains

The syntax for **dbcc checkstorage** is:

```
dbcc checkstorage [(dbname)]
```

where *dbname* is the name of the **target database** (the database to be checked).

Advantages of Using *dbcc checkstorage*

The **dbcc checkstorage** command:

- Combines many of the checks provided by the other **dbcc** commands
- Does not lock tables or pages for extended periods, which allows **dbcc** to locate errors accurately while allowing concurrent update activity
- Scales linearly with the aggregate I/O throughput
- Separates the functions of checking and reporting, which allows custom evaluation and report generation
- Provides a detailed description of space usage in the target database
- Records **dbcc checkstorage** activity and results in the *dbccdb* database, which allows trend analysis and provides a source of accurate diagnostic information

Comparison of *dbcc checkstorage* and Other *dbcc* Commands

dbcc checkstorage is different from the other **dbcc** commands in that it requires:

- The *dbccdb* database to store configuration information and the results of checks made on the target database. For more information, see “Preparing to Use dbcc checkstorage” on page 25-29.
- At least two workspaces to use during the check operation. See “dbccdb Workspaces” on page 12-13 in the *Adaptive Server Reference Manual*
- System and stored procedures to help you prepare your system to use **dbcc checkstorage** and to generate reports on the data stored in *dbccdb*. See “Preparing to Use dbcc checkstorage” on page 25-29, “Maintaining dbccdb” on page 25-41, and “Generating Reports from dbccdb” on page 25-43.

dbcc checkstorage does not repair any faults. After you run **dbcc checkstorage** and generate a report to see the faults, you can run the appropriate **dbcc** command to repair the faults.

Understanding the *dbcc checkstorage* Operation

The **dbcc checkstorage** operation consists of the following steps:

1. Inspection – **dbcc checkstorage** uses the device allocation and the segment definition of the database being checked to determine the level of parallel processing that can be used. **dbcc checkstorage** also uses the configuration parameters **max worker processes** and **dbcc named cache** to limit the level of parallel processing that can be used.
2. Planning – **dbcc checkstorage** generates a plan for executing the operation that takes advantage of the parallelism discovered in step 1.
3. Execution and optimization – **dbcc checkstorage** uses Adaptive Server worker processes to perform parallel checking and storage analysis of the **target database**. It attempts to equalize the work performed by each worker process and consolidates the work of underutilized worker processes. As the check operation proceeds, **dbcc checkstorage** extends and adjusts the plan generated in step 2 to take advantage of the additional information gathered during the check operation.
4. Reporting and control – During the check operation, **dbcc checkstorage** records in the *dbccdb* database all the faults it finds in the target database for later reporting and evaluation. It also records the results of its storage analysis in *dbccdb*. When **dbcc checkstorage** encounters a fault, it attempts to recover and continue the operation, but ends operations that cannot succeed after the fault. For example, a defective disk does not cause **dbcc checkstorage** to fail; however, check operations performed on the defective disk cannot succeed, so they are not performed.

   If another session performs **drop table** concurrently, **dbcc checkstorage** might fail in the initialization phase. If this happens, run **dbcc checkstorage** again when the drop table process is finished.

Performance and Scalability

dbcc checkstorage scales linearly with aggregate I/O throughput for a substantial performance improvement over **dbcc checkalloc**. The scaling property of **dbcc checkstorage** means that if the database doubles in size and the hardware doubles in capacity (realizable I/O throughput), the time required for a **dbcc** check remains unchanged. Doubling the capacity would typically mean doubling the number of

disk spindles and providing sufficient additional I/O channel capacity, system bus capacity, and CPU capacity to realize the additional aggregate disk throughput.

Most of the checks performed by using **dbcc checkalloc** and **dbcc checkdb**, including text column chain verification, are achieved with a single check when you use **dbcc checkstorage**, thereby eliminating redundant check operations.

dbcc checkstorage checks the entire database, including unused pages, so execution time is relative to database size. Therefore, when you use **dbcc checkstorage**, there is not a large difference between checking a database that is nearly empty and checking one that is nearly full, as there is with the other **dbcc** commands.

Unlike the other **dbcc** commands, the performance of **dbcc checkstorage** does not depend heavily on data placement. Therefore, performance is consistent for each session, even if the data placement changes between sessions.

Because **dbcc checkstorage** does extra work to set up the parallel operation and records large amounts of data in *dbccdb*, the other **dbcc** commands are faster when the target database is small.

The location and allocation of the workspaces used by **dbcc checkstorage** can affect performance and scalability. For more information on how to set up the workspaces to maximize the performance and scalability of your system, see “dbccdb Workspaces” on page 12-13 in the *Adaptive Server Reference Manual*.

To run **dbcc checkstorage** and one of the system procedures for generating reports with a single command, use **sp_dbcc_runcheck**. For information on the report generating system procedures, see “Generating Reports from dbccdb” on page 25-43.

dbcc checktable

dbcc checktable checks the specified table to see that:

- Index and data pages are linked correctly
- Indexes are sorted properly
- Pointers are consistent
- Data rows on each page have entries in the row-offset table; these entries match the locations for the data rows on the page
- Data rows on each page have entries in the row-offset table in the page that match their respective locations on the page

- Partition statistics for partitioned tables are correct

The syntax for **dbcc checktable** is:

```
dbcc checktable ({table_name | table_id}
   [, skip_ncindex] )
```

The **skip_ncindex** option allows you to skip checking the page linkage, pointers, and sort order on nonclustered indexes. The linkage and pointers of clustered indexes and data pages are essential to the integrity of your tables. You can drop and re-create nonclustered indexes if Adaptive Server reports problems with page linkage or pointers.

When **checkstorage** returns a fault code of 100035, and **checkverify** confirms that the spacebit fault is a hard fault, you can use **dbcc checktable** to fix the reported fault.

The syntax is:

```
dbcc checktable (table_name, fix_spacebits)
```

where *table_name* is the name of the table to repair.

dbcc checktable can be used with the table name or the table's object ID. The *sysobjects* table stores this information in the *name* and *id* columns.

The following example shows a report on an undamaged table:

```
dbcc checktable(titles)
go

Checking titles
The total number of data pages in this table is 3.
Table has 18 data rows.

DBCC execution completed. If DBCC printed error
messages, contact a user with System Administrator
(SA) role.
```

If the table is partitioned, **dbcc checktable** checks data page linkage and partition statistics for each partition. For example:

```
dbcc checktable(historytab)
go
```

```
Checking historytab
The total number of pages in partition 1 is 20.
The total number of pages in partition 2 is 17.
The total number of pages in partition 3 is 19.
The total number of pages in partition 4 is 17.
The total number of pages in partition 5 is 20.
The total number of pages in partition 6 is 16.
The total number of pages in partition 7 is 19.
The total number of pages in partition 8 is 17.
The total number of pages in partition 9 is 19.
The total number of pages in partition 10 is 16.

The total number of data pages in this table is
190.
Table has 1536 data rows.

DBCC execution completed. If DBCC printed error
messages, contact a user with System Administrator
(SA) role.
```

For more information, see "Commands for Partitioning Tables" on page 33-21 in the *Performance and Tuning Guide.*

To check a table that is not in the current database, supply the database name. To check a table owned by another object, supply the owner's name. You must enclose any qualified table name in quotes. For example:

```
dbcc checktable("pubs2.newuser.testtable")
```

dbcc checktable addresses the following problems:

- If the page linkage is incorrect, **dbcc checktable** displays an error message.
- If the sort order (*sysindexes.soid*) or character set (*sysindexes.csid*) for a table with columns with *char* or *varchar* datatypes is incorrect, and the table's sort order is compatible with Adaptive Server's default sort order, **dbcc checktable** corrects the values for the table. Only the binary sort order is compatible across character sets.

➤ ***Note***

If you change sort orders, character-based user indexes are marked "read-only" and must be checked and rebuilt, if necessary. See Chapter 19, "Configuring Character Sets, Sort Orders, and Languages," for more information about changing sort orders.

- If data rows are not accounted for in the first OAM page for the object, **dbcc checktable** updates the number of rows on that page. This is not a serious problem. The built-in function **rowcnt** uses this value to provide fast row estimates in procedures like **sp_spaceused.**

You can improve **dbcc checktable** performance by using enhanced page fetching.

dbcc checkdb

dbcc checkdb runs the same checks as **dbcc checktable** on each table in the specified database. If you do not give a database name, **dbcc checkdb** checks the current database. **dbcc checkdb** gives similar messages to those returned by **dbcc checktable** and makes the same types of corrections.

The syntax for **dbcc checkdb** is:

```
dbcc checkdb [(database_name [, skip_ncindex]) ]
```

If you specify the optional **skip_ncindex**, **dbcc checkdb** does not check any of the nonclustered indexes on user tables in the database.

Checking Page Allocation

The **dbcc** commands that you use to check page allocation are:

- **dbcc checkalloc**
- **dbcc indexalloc**
- **dbcc tablealloc**

dbcc checkalloc

dbcc checkalloc ensures that:

- All pages are correctly allocated.
- Partition statistics on the allocation pages are correct.
- No page is allocated that is not used.
- No page is used that is not allocated.

The syntax for **dbcc checkalloc** is:

```
dbcc checkalloc [(database_name [, fix | nofix] )]
```

If you do not provide a database name, **dbcc checkalloc** checks the current database.

With the **fix** option, **dbcc checkalloc** can fix all allocation errors that would otherwise be fixed by **dbcc tablealloc** and can also fix pages that remain allocated to objects that have been dropped from the database. Before you can use **dbcc checkalloc** with the **fix** option, you must put the database into single-user mode. For details on using the **fix** and **no fix** options, see "Correcting Allocation Errors Using the fix | nofix Option" on page 25-17.

dbcc checkalloc output consists of a block of data for each table, including the system tables and the indexes on each table. For each table or index, it reports the number of pages and extents used. Table information is reported as either INDID=0 or INDID=1. Tables without clustered indexes have INDID=0, as shown in the example report on the *salesdetail* table. Tables with clustered indexes have INDID=1. The report for these indexes includes information at both the data and index level, as shown in the example reports on *titleauthor* and *titles*. Nonclustered indexes are numbered consecutively, starting with INDID=2.

The following report on *pubs2* shows the output for the *salesdetail*, *titleauthor*, and *titles* tables:

```
************************************************************
TABLE: salesdetail              OBJID = 144003544
INDID=0  FIRST=297       ROOT=299        SORT=0
        Data level: 0.  3 Data  Pages in 1 extents.
INDID=2  FIRST=289       ROOT=290        SORT=1
        Indid     : 2.  3 Index Pages in 1 extents.
INDID=3  FIRST=465       ROOT=466        SORT=1
        Indid     : 3.  3 Index Pages in 1 extents.
TOTAL # of extents = 3
************************************************************
TABLE: titleauthor              OBJID = 176003658
INDID=1  FIRST=433       ROOT=425        SORT=1
        Data level: 1.  1 Data  Pages in 1 extents.
        Indid     : 1.  1 Index Pages in 1 extents.
INDID=2  FIRST=305       ROOT=305        SORT=1
        Indid     : 2.  1 Index Pages in 1 extents.
INDID=3  FIRST=441       ROOT=441        SORT=1
        Indid     : 3.  1 Index Pages in 1 extents.
```

```
TOTAL # of extents = 4
**********************************************************
TABLE: titles           OBJID = 208003772
INDID=1  FIRST=417       ROOT=409        SORT=1
        Data level: 1.  3 Data  Pages in 1 extents.
        Indid     : 1.  1 Index Pages in 1 extents.
INDID=2  FIRST=313       ROOT=313        SORT=1
        Indid     : 2.  1 Index Pages in 1 extents.
TOTAL # of extents = 3
**********************************************************
```

dbcc indexalloc

dbcc indexalloc checks the specified index to see that:

- All pages are correctly allocated.
- No page is allocated that is not used.
- No page is used that is not allocated.

dbcc indexalloc is an index-level version of **dbcc checkalloc**, providing the same integrity checks on an individual index. You can specify either the table name or the table's object ID (the *id* column in *sysobjects*) and the index's *indid* in *sysindexes*. **dbcc checkalloc** and **dbcc indexalloc** include the index IDs in their output.

The syntax for **dbcc indexalloc** is:

```
dbcc indexalloc ( {table_name | table_id }, index_id
   [, {full | optimized | fast | null}
   [, fix | nofix]])
```

If you want to use the **fix** or **nofix** option for **dbcc indexalloc**, you must also specify one of the report options (**full**, **optimized**, **fast**, or **null**). For details on using the **fix** and **no fix** options, see "Correcting Allocation Errors Using the fix | nofix Option" on page 25-17. For details on the reports, see "Generating Reports with dbcc tablealloc and dbcc indexalloc" on page 25-18.

You can run **sp_indsuspect** to check the consistency of sort order in indexes and **dbcc reindex** to repair inconsistencies. For details see "Using sp_indsuspect to Find Corrupt Indexes" on page 19-14 and "Rebuilding Indexes After Changing the Sort Order" on page 19-14.

dbcc tablealloc

dbcc tablealloc checks the specified user table to ensure that:

- All pages are correctly allocated.
- Partition statistics on the allocation pages are correct.
- No page is allocated that is not used.
- No page is used that is not allocated.

The syntax for **dbcc tablealloc** is:

```
dbcc tablealloc ({table_name | table_id}
   [, {full | optimized | fast | null}
   [, fix | nofix]])
```

You can specify either the table name or the table's object ID from the *id* column in *sysobjects*.

If you want to use the **fix** or **nofix** options for **dbcc tablealloc**, you must also specify one of the report options (**full**, **optimized**, **fast**, or **null**). For details on using the **fix** and **no fix** options, see "Correcting Allocation Errors Using the fix | nofix Option" on page 25-17. For details on the reports, see "Generating Reports with dbcc tablealloc and dbcc indexalloc" on page 25-18.

Correcting Allocation Errors Using the *fix* | *nofix* Option

You can use the **fix** | **nofix** option with **dbcc checkalloc**, **dbcc tablealloc**, and **dbcc indexalloc**. It specifies whether or not the command fixes the allocation errors in tables. The default for all user tables is **fix**. The default for all system tables is **nofix**.

Before you can use the **fix** option on system tables, you must put the database into single-user mode:

```
sp_dboption dbname, "single user", true
```

You can issue this command only when no one is using the database. While it is in effect, only the user who issued it can access the database. Because of this, we recommend that you run **dbcc checkalloc** with **nofix**, so that the database is available to other users, and then use **dbcc tablealloc** or **dbcc indexalloc** with **fix** to correct errors in individual tables or indexes.

Output from **dbcc tablealloc** with **fix** displays allocation errors and any corrections that were made. The following example shows an error message that appears whether or not the **fix** option is used:

```
Msg 7939, Level 22, State 1:
Line 2:
Table Corrupt: The entry is missing from the OAM
for object id 144003544 indid 0 for allocation
page 2560.
```

When you use **fix**, the following message indicates that the missing entry has been restored:

```
The missing OAM entry has been inserted.
```

The **fix|nofix** option works the same in **dbcc indexalloc** as it does in **dbcc tablealloc**.

Generating Reports with *dbcc tablealloc* and *dbcc indexalloc*

You can generate three types of reports with **dbcc tablealloc** or **dbcc indexalloc**:

- **full** – produces a report containing all types of allocation errors. Using the **full** option with **dbcc tablealloc** gives the same results as using **dbcc checkalloc** at a table level.
- **optimized** – produces a report based on the allocation pages listed in the OAM pages for the table. When you use the **optimized** option, **dbcc tablealloc** does not report and cannot fix unreferenced extents on allocation pages that are not listed in the OAM pages. If you do not specify a report type, or if you specify **null**, **optimized** is the default.
- **fast** – produces an exception report of pages that are referenced but not allocated in the extent (2521-level errors); does not produce an allocation report.

For a comparison of speed, completeness, locking, and performance issues for these options and other **dbcc** commands, see Table 25-2 on page 25-20.

Checking Consistency of System Tables

dbcc checkcatalog checks for consistency within and between the system tables in a database. For example, it verifies that:

- Every type in *syscolumns* has a matching entry in *systypes*.
- Every table and view in *sysobjects* has at least one column in *syscolumns*.
- The last checkpoint in *syslogs* is valid.

It also lists the segments defined for use by the database.

The syntax for **dbcc checkcatalog** is:

```
dbcc checkcatalog [(database_name)]
```

If you do not specify a database name, **dbcc checkcatalog** checks the current database.

```
dbcc checkcatalog (testdb)
```

```
Checking testdb
The following segments have been defined for database 5
(database name testdb).
virtual start addr      size      segments
-------------------     ------    -------------------------
33554432                4096       0
                                   1
16777216                102        2
DBCC execution completed. If DBCC printed error messages, see
your System Administrator.
```

Strategies for Using Consistency Checking Commands

The following sections compare the performance of the **dbcc** commands, provide suggestions for scheduling and strategies to avoid serious performance impacts, and provide information about **dbcc** output.

Comparing the Performance of *dbcc* Commands

Table 25-2 compares the speed, thoroughness, the level of checking and locking, and performance implications of the **dbcc** commands. Remember that **dbcc checkdb**, **dbcc checktable**, and **dbcc checkcatalog** perform different types of integrity checks than **dbcc checkalloc**, **dbcc tablealloc**, and **dbcc indexalloc**. **dbcc checkstorage** performs a combination of the some of the checks performed by the other commands. Table

25-1 on page 25-7 shows which checks are performed by the commands.

Table 25-2: Comparison of the performance of dbcc commands

Command and Option	Level	Locking and Performance	Speed	Thoroughness
checkstorage	Page chains and data rows for all indexes, allocation pages, OAM pages, device and partition statistics	No locking; performs extensive I/O and may saturate the system's I/O; can use dedicated cache with minimal impact on other caches	Fast	High
checktable **checkdb**	Page chains, sort order, data rows, and partition statistics for all indexes	Shared table lock; **dbcc checkdb** locks one table at a time and releases the lock after it finishes checking that table	Slow	High
checktable **checkdb** with **skip_ncindex**	Page chains, sort order, and data rows for tables and clustered indexes	Shared table lock; **dbcc checkdb** locks one table at a time and releases the lock after it finishes checking that table	Up to 40% faster than without **skip_ncindex**	Medium
checkalloc	Page chains and partition statistics	No locking; performs extensive I/O and may saturate the I/O calls; only allocation pages are cached	Slow	High
tablealloc full **indexalloc full** with **full**	Page chains	Shared table lock; performs extensive I/O; only allocation pages are cached	Slow	High
tablealloc **indexalloc** with **optimized**	Allocation pages	Shared table lock; performs extensive I/O; only allocation pages are cached	Moderate	Medium
tablealloc **indexalloc** with **fast**	OAM pages	Shared table lock	Fast	Low
checkcatalog	Rows in system tables	Shared page locks on system catalogs; releases lock after each page is checked; very few pages cached	Moderate	Medium

Using Large I/O and Asynchronous Prefetch

Some **dbcc** commands can use large I/O and asynchronous prefetch when these are configured for the caches used by the databases or objects to be checked.

dbcc checkdb and **dbcc checktable** use large I/O pools for the page chain checks on tables when the tables use a cache with large I/O configured. The largest I/O size available is used. When checking indexes, **dbcc** uses only 2K buffers.

The **dbcc checkdb**, **dbcc checktable**, and the **dbcc** allocation checking commands, **checkalloc**, **tablealloc** and **indexalloc**, use asynchronous prefetch when it is available for the pool in use. See "Setting Asynchronous Prefetch Limits for dbcc" on page 34-14 in the *Performance and Tuning Guide* for more information.

Cache binding commands and the commands to change the size and asynchronous prefetch percentages for pools are dynamic commands. If you use these **dbcc** commands during off-peak periods, when user applications experience little impact, you can change these settings to speed **dbcc** performance and restore the normal settings when **dbcc** checks are finished. See Chapter 15, "Configuring Data Caches," for information on these commands.

Scheduling Database Maintenance at Your Site

There are several factors that determine how often you should run **dbcc** commands and which ones you need to run.

Database Use

If your Adaptive Server is used primarily between the hours of 8:00 a.m. and 5:00 p.m., Monday through Friday, you can run **dbcc** checks at night and on weekends so that the checks do not have a significant impact on your users. If your tables are not extremely large, you can run a complete set of **dbcc** commands fairly frequently.

dbcc checkstorage and **dbcc checkcatalog** provide the best coverage at the lowest cost, assure recovery from backups. You can run **dbcc checkdb** or **dbcc checktable** less frequently to check index sort order and consistency. This check does not need to be coordinated with any other database maintenance activity. Reserve object-level **dbcc** checks and those checks that use the **fix** option for further diagnosis and correction of faults found by **dbcc checkstorage**.

If your Adaptive Server is used 24 hours a day, 7 days a week, you may want to limit the resource usage of **dbcc checkstorage** by limiting the number of worker processes or by using application queues. If you decide not to use **dbcc checkstorage**, you may want to schedule a cycle of checks on individual tables and indexes using **dbcc checktable**, **dbcc tablealloc**, and **dbcc indexalloc**. At the end of the cycle, when all tables have been checked, you can run **dbcc checkcatalog** and back up the database. For information on using application queues, see Chapter 38, "Distributing Engine Resources Between Tasks," in the *Performance and Tuning Guide*.

Some sites with 24-hour, high-performance demands run **dbcc** checks by:

- Dumping the database to tape
- Loading the database dump into a separate Adaptive Server to create a duplicate database
- Running **dbcc** commands on the duplicate database
- Running **dbcc** commands with the **fix** options on appropriate objects in the original database, if errors are detected that can be repaired with the **fix** options

The dump is a logical copy of the database pages; therefore, problems found in the original database are present in the duplicate database. This strategy is useful if you are using dumps to provide a duplicate database for reporting or some other purpose.

Schedule the use of **dbcc** commands that lock objects to avoid interference with business activities. For example, **dbcc checkdb** acquires locks on all objects in the database while it performs the check. You cannot control the order in which it checks the objects. If you are running an application that uses *table4*, *table5*, and *table6*, and running **dbcc checkdb** takes 20 minutes to complete, the application will be blocked from accessing these tables, even when the command is not checking them.

Backup Schedule

The more often you back up your databases and dump your transaction logs, the more data you can recover in case of failure. You must decide how much data you are willing to lose in the event of a disaster and develop a dump schedule to support that decision.

After you schedule your dumps, decide how to incorporate the **dbcc** commands into that schedule. You do not have to perform **dbcc**

checks before each dump; however, you may lose additional data if a corruption occurs in the dumps.

An ideal time to dump a database is after you run a complete check of that database using **dbcc checkstorage** and **dbcc checkcatalog**. If these commands find no errors in the database, you know that your backup contains a clean database. You can correct problems that occur after loading the dump by reindexing. Use **dbcc tablealloc** or **indexalloc** on individual tables and indexes to correct allocation errors reported by **dbcc checkalloc**.

Size of Tables and Importance of Data

Answer the following questions about your data:

- How many tables contain highly critical data?
- How often does that data change?
- How large are those tables?

dbcc checkstorage is a database-level operation. If only a few tables contain critical data or data that changes often, you may want to run the table- and index-level **dbcc** commands more frequently on those tables than you run **dbcc checkstorage** on the entire database.

Understanding the Output from *dbcc* commands

dbcc checkstorage stores the results in the *dbccdb* database. You can print a variety of reports from this database. For details, see "dbcc checkstorage" on page 25-8.

The output of most other **dbcc** commands includes information that identifies the objects being checked and error messages that indicate any problems, the command finds in the object. When you run **dbcc tablealloc** and **dbcc indexalloc** with **fix**, the output also indicates the repairs that the command makes.

The following example shows **dbcc tablealloc** output for a table with an allocation error:

```
dbcc tablealloc(table5)
```

Information from *sysindexes* about the object being checked:

```
TABLE: table5            OBJID = 144003544
INDID=0  FIRST=337       ROOT=2587       SORT=0
```

Error message:

```
Msg 7939, Level 22, State 1:
Line 2:
Table Corrupt: The entry is missing from the OAM for object id
144003544 indid 0 for allocation page 2560.
```

Message indicating that the error has been corrected:

```
The missing OAM entry has been inserted.
        Data level: 0.  67 Data  Pages in 9 extents.
```

***dbcc* report on page allocation:**

```
TOTAL # of extents = 9
Alloc page 256 (# of extent=1 used pages=8 ref pages=8)
EXTID:560 (Alloc page: 512) is initialized.  Extent follows:
NEXT=0 PREV=0 OBJID=144003544 ALLOC=0xff DEALL=0x0 INDID=0 STATUS=0x0
Alloc page 512 (# of extent=2 used pages=8 ref pages=8)
Page 864 allocated (Alloc page: 768 Extent ID: 864 Alloc mask: 0x1)
Page 865 allocated (Alloc page: 768 Extent ID: 864 Alloc mask: 0x3)
Page 866 allocated (Alloc page: 768 Extent ID: 864 Alloc mask: 0x7)
Page 867 allocated (Alloc page: 768 Extent ID: 864 Alloc mask: 0xf)
Page 868 allocated (Alloc page: 768 Extent ID: 864 Alloc mask: 0x1f)
Page 869 allocated (Alloc page: 768 Extent ID: 864 Alloc mask: 0x3f)
Page 870 allocated (Alloc page: 768 Extent ID: 864 Alloc mask: 0x7f)
Page 871 allocated (Alloc page: 768 Extent ID: 864 Alloc mask: 0xff)
Alloc page 768 (# of extent=1 used pages=8 ref pages=8)
Alloc page 1024 (# of extent=1 used pages=8 ref pages=8)
Alloc page 1280 (# of extent=1 used pages=8 ref pages=8)
Alloc page 1536 (# of extent=1 used pages=8 ref pages=8)
Alloc page 1792 (# of extent=1 used pages=8 ref pages=8)
Alloc page 2048 (# of extent=1 used pages=8 ref pages=8)
```

(Other output deleted.)

Information on resources used:

```
Statistical information for this run follows:

Total # of pages read = 68
Total # of pages found cache = 68
Total # of physical reads = 0
Total # of saved I/O = 0
```

Message printed on completion of *dbcc* command:

```
DBCC execution completed. If DBCC printed error messages, contact a user
with System Administrator (SA) role.
```

Errors Generated by Database Consistency Problems

Errors generated by database consistency problems encountered by **dbcc checkstorage** are documented in the *dbcc_types* table. Most are in the ranges 5010–5019 and 100,000–100,032. For information on specific errors, see “dbcc_types” on page 12-6 of the *Adaptive Server*

Reference Manual. **dbcc checkstorage** records two kinds of faults: soft and hard. For information, see "Comparison of Soft and Hard Faults" on page 25-25.

Errors generated by database consistency problems encountered by **dbcc** commands other than **dbcc checkstorage** usually have error numbers from 2500 to 2599 or from 7900 to 7999. These messages, and others that can result from database consistency problems (such as Error 605), may include phrases like "Table Corrupt" or "Extent not within segment."

Some messages indicate severe database consistency problems; others are not so urgent. A few may require help from Sybase Technical Support, but most can be solved by:

- Running **dbcc** commands that use the **fix** option
- Following the instructions in the *Troubleshooting Guide*, which contains step-by-step instructions for resolving many database errors found by **dbcc**

Whatever techniques are required to solve the problems, the solutions are much easier when you find the problem soon after the occurrence of the corruption or inconsistency. Consistency problems can exist on data pages that are not used frequently, such as a table that is updated only monthly. **dbcc** can find, and often fix, these problems for you.

Comparison of Soft and Hard Faults

When **dbcc checkstorage** finds a fault in the target database, it is recorded in the *dbcc_faults* table as either a **soft fault** or a **hard fault**. The following sections describe the two kinds of faults. For more information, see "Verifying Faults with dbcc checkverify" on page 25-26.

Soft Faults

A **soft fault** is an inconsistency in Adaptive Server that is usually not persistent. Most soft faults result from temporary inconsistencies in the target database caused by users updates to the database during **dbcc checkstorage** or when **dbcc checkstorage** encounters data definition language (DDL) commands. These faults are not repeated when you run the command a second time. You can reclassify soft faults by comparing the results of the two executions of **dbcc checkstorage** or by

running **dbcc tablealloc** and **dbcc checktable** after **dbcc checkstorage** finds soft faults.

If the same soft faults occur in successive executions of **dbcc checkstorage**, they are "persistent" soft faults, and may indicate a corruption. If you execute **dbcc checkstorage** in single-user mode, the soft faults reported are "persistent" soft faults. You can resolve these faults by using **sp_dbcc_differentialreport** or by running **dbcc tablealloc** and **dbcc checktable**. If you use the latter two commands, you need to check only the tables or indexes that exhibited the soft faults.

Hard Faults

A **hard fault** is a persistent corruption of Adaptive Server that cannot be corrected by restarting Adaptive Server. Not all hard faults are equally severe. For example, each of the following situations cause a hard fault, but the results are different:

- A page that is allocated to a nonexistent table minimally reduces the available disk storage.
- A table with some rows that are unreachable by a scan might return the wrong results.
- A table that is linked to another table causes the query to stop.

Some hard faults can be corrected by simple actions such as truncating the affected table. Others can be corrected only by restoring the database from a backup.

Verifying Faults with *dbcc checkverify*

dbcc checkverify examines the results of the most recent **checkstorage** operation and reclassifies each soft fault as either a hard fault or an insignificant fault. **checkverify** acts as a second filter to remove spurious faults from the **checkstorage** results.

How *dbcc checkverify* Works

checkverify reads the recorded faults from *dbcc_faults* and resolves each soft fault through a procedure similar to that used by the **checkstorage** operation.

➤ ***Note***

checkverify locks the table against concurrent updates, which ensures that the soft faults are reclassified correctly. **checkverify** does not find errors that have occurred since the last run of **checkstorage**.

checkverify records information in the *dbcc_operation_log* and *dbcc_operation_results* tables the same way that **checkstorage** does. The recorded value of *opid* is the same as the *opid* of the last **checkstorage** operation. **checkverify** updates the *status* column in the *dbcc_faults* table and inserts a row in the *dbcc_fault_params* table for the faults it processes.

checkverify does not use the *scan* or *text* workspaces.

Each fault found by **checkstorage** is verified by **checkverify** as one of the following:

- A hard fault classified as such by **checkstorage**.
- A soft fault reclassified as hard by **checkverify** because concurrent activity was ruled out as the cause.
- A soft fault confirmed to be soft by **checkverify.** Some soft faults that appear when there is no concurrent activity in the database do not represent a significant hazard and are not reclassified as hard. A soft fault is not reclassified if it is informational only and not a corruption.
- A soft fault reclassified as insignificant because it can be attributed to concurrent activity or because subsequent activity masked the original inconsistency.

A fault that is assigned code 100011 (text pointer fault) by **checkstorage** is verified as hard if the text column has a hard fault. If it does not, it is reclassified as soft.

A fault that is assigned code 100016 (page allocated but not linked) by **checkstorage** is verified as hard if the same fault appears in two successive **checkstorage** operations. Otherwise, it is reclassified as soft.

When a fault that is assigned code 100035 (spacebits mismatch) by **checkstorage** is verified as hard, you can repair it by using **dbcc checktable**.

When **checkverify** confirms hard faults in your database, follow the same procedures as you did in version 11.5 to correct the faults.

checkverify classifies the following fault codes as soft faults:

- 100020 – check aborted

- 100025 – row count fault
- 100028 – page allocation off current segment

When to Use *dbcc checkverify*

You can verify persistent faults by running **checkverify** anytime after running **checkstorage**, even after an extended period of hours or days. However, when deciding your schedule, keep in mind that the database state changes over time, and the changes can mask both soft faults and hard faults.

For example, a page that is linked to a table but not allocated is a hard fault. If the table is dropped, the fault is resolved and masked. If the page is allocated to another table, the fault persists but its signature changes. The page now appears to be linked to two different tables. If the page is reallocated to the same table, the fault appears as a corrupt page chain.

Persistent faults that are corrected by a subsequent database change usually do not pose an operational problem. However, detecting and quickly verifying these faults may locate a source of corruption before more serious problems are encountered or before the signature of the original fault changes. For this reason, Sybase recommends that you run **checkverify** as soon as possible after running **dbcc checkstorage**.

➤ ***Note***

When **checkstorage** is executed with the target database in single-user mode, there will be no soft faults and no need to execute **checkverify**.

checkverify runs only one time for each execution of **checkstorage**. However, if **checkverify** is interrupted and does not complete, you can run it again. The operation resumes from where it was interrupted.

How to Use *dbcc checkverify*

The syntax is:

```
dbcc checkverify(dbname)
```

where *dbname* is the database for which you want to verify **checkstorage** results.

checkverify operates on the results of the last completed **checkstorage** operation for the specified database only.

When the **checkverify** operation is complete, Adaptive Server returns the following message:

```
DBCC checkverify for database name, sequence
n completed at date time. n suspect conditions
resolved as faults and n resolved as innocuous.
n checks were aborted.
```

You can run **checkverify** automatically after running **checkstorage** by using **sp_dbcc_runcheck**.

Dropping a Damaged Database

Use **dbcc dbrepair dropdb** from the *master* database to drop a damaged database. No users, including the user running **dbrepair**, can be using the database when it is dropped.

The syntax for **dbcc dbrepair** is:

dbcc dbrepair (*database_name*, dropdb)

The Transact-SQL command **drop database** does not work on a database that cannot be recovered or used.

Preparing to Use *dbcc checkstorage*

Before you can use **dbcc checkstorage**, you must configure Adaptive Server and set up the *dbccdb* database. Table 25-3 summarizes the steps and commands in the order you should use them. Each action is described in detail in the following sections.

◆ ***WARNING!***

Do not attempt to perform the actions or use the commands in Table 25-3 before you read the information in the referenced section. You must understand the consequences of each action before you make any changes.

Table 25-3: Tasks for preparing to use *dbcc checkstorage*

For This Action	See	Use This Command
1. Obtain recommendations for database size, devices (if *dbccdb* does not exist), workspace sizes, cache size, and the number of worker processes for the target database.	"Planning Resources" on page 25-31 "Planning Workspace Size" on page 25-33	**use master** **sp_plan_dbccdb**
2. If necessary, adjust the number of worker processes that Adaptive Server uses.	"Configuring Worker Processes" on page 25-34	**sp_configure** **number of worker processes** **memory per worker process**
3. Create a named cache for **dbcc** (optional).	"Setting Up a Named Cache for dbcc" on page 25-36	**sp_cacheconfig**
4. Configure a 16K I/O buffer pool.	"Configuring a 16K I/O buffer pool" on page 25-37	**sp_poolconfig**
5. If *dbccdb* already exists, drop it and all associated devices before creating a new *dbccdb* database.		**drop database**
6. Initialize disk devices for the *dbccdb* data and the log.	"Allocating Disk Space for dbccdb" on page 25-37	**disk init**
7. Create *dbccdb* on the data disk device.		**create database**
8. Add disk segments (optional).	"Segments for Workspaces" on page 25-38	**use dbccdb** **sp_addsegment**
9. Populate the *dbccdb* database and install **dbcc** stored procedures.		**isql -Usa -P -i $SYBASE/scripts/installdbccdb**
10. Create the workspaces.	"dbccdb Workspaces" on page 12-13	**sp_dbcc_createws**

Table 25-3: Tasks for preparing to use *dbcc checkstorage (continued)*

For This Action	See	Use This Command
11. Update configuration values.	"Updating the dbcc_config Table" on page 25-40	**sp_dbcc_updateconfig** **max worker processes** **dbcc named cache** **scan workspace** **text workspace** **OAM count threshold** **IO error abort** **linkage error abort**

Planning Resources

Selecting the appropriate device and size for *dbccdb* is critical to the performance of **dbcc checkstorage** operations. **sp_plan_dbccdb** provides configuration recommendations or facts for the specified target database depending on whether *dbccdb* exists or not. You use this information to configure Adaptive Server and set up the *dbccdb* database.

Examples of *sp_plan_dbccdb* Output

If *dbccdb* does not exist, **sp_plan_dbccdb** returns:

- Minimum size for *dbccdb*
- Devices that are suitable for *dbccdb*
- Minimum sizes for the *scan* and *text* workspaces
- Minimum cache size
- Number of worker processes

The values recommended for the cache size are approximate because the optimum cache size for *dbccdb* depends on the pattern of the page allocation in the target database. The following example shows the output of **sp_plan_dbccdb** for the *pubs2* database when *dbccdb* does not exist:

```
sp_plan_dbccdb pubs2
```

```
Recommended size for dbccdb is 4MB.

Recommended devices for dbccdb are:

Logical Device Name   Device Size   Physical Device Name

sprocdev              28672         /remote/SERV/sprocs_dat
tun_dat               8192          /remote/SERV/tun_dat
tun_log               4096          /remote/SERV/tun_log

Recommended values for workspace size, cache size and process
count are:

dbname        scan ws    text ws    cache    process count

pubs2         64K         64K        640K     1
```

If *dbccdb* already exists, **sp_plan_dbccdb** returns:

- Minimum size for *dbccdb*
- Size of existing *dbccdb* database
- Minimum sizes for the *scan* and *text* workspaces
- Minimum cache size
- Number of worker processes

The following example shows the output of **sp_plan_dbccdb** for the *pubs2* database when *dbccdb* already exists:

```
sp_plan_dbccdb pubs2
```

```
Recommended size for dbccdb database is 23MB (data = 21MB, log = 2MB).

dbccdb database already exists with size 8MB.

Recommended values for workspace size, cache size and process count are:

dbname                          scan ws    text ws    cache    process
count

pubs2                            64K        48K        640K     1
```

If you plan to check more than one database, use the name of the largest one for the target database. If you do not provide a target database name, **sp_plan_dbccdb** returns configuration values for all databases listed in *master..sysdatabases*, as shown in the following example:

```
sp_plan_dbccdb
```

```
Recommended size for dbccdb is 4MB.

dbccdb database already exists with size 8MB.

Recommended values for workspace size, cache size and process
count are:

dbname           scan ws    text ws    cache    process count

master            64K        64K        640K     1
tempdb            64K        64K        640K     1
model             64K        64K        640K     1
sybsystemprocs   384K       112K       1280K     2
pubs2             64K        64K        640K     1
pubs3             64K        64K        640K     1
pubtune          160K        96K       1280K     2
sybsecurity       96K        96K       1280K     2
dbccdb           112K        96K      1280K      2
```

For more information, see **sp_plan_dbccdb** in the *Adaptive Server Reference Manual*.

Planning Workspace Size

Two workspaces are required for *dbccdb*: *scan* and *text*. Space requirements for the workspaces depend on the size of the largest database that will be checked. To run concurrent **dbcc checkstorage** operations, you'll need to set up additional workspaces.

Determining the SIze for the Largest Database to be Checked

Different databases can use the same workspaces. Therefore, the workspaces must be large enough to accommodate the largest database with which they will be used.

➤ ***Note***

sp_plan_dbccdb suggests workspace sizes – the following details for determining the workspace size are provided for background information only.

Each page in the target database is represented by one 18-byte row in the *scan* workspace. This workspace should be approximately 1.1 percent of the target database size.

Every non-null *text* column in the target database inserts a 22-byte row in the *text* workspace. If there are *n* non-null *text* columns in the target database, the size of the *text* workspace must be at least (22 * *n*) bytes. The number of non-null *text* columns is dynamic, so allocate enough space for the *text* workspace to accommodate future demands. The minimum space required for the *text* workspace is 24 pages.

Number of Workspaces That Can Be Used Concurrently

You can configure *dbccdb* to run **dbcc checkstorage** concurrently on multiple databases. This is possible only when the second and subsequent **dbcc checkstorage** operations have their own dedicated resources. To perform concurrent **dbcc checkstorage** operations, each operation must have its own *scan* and *text* workspaces, worker processes, and reserved cache.

The total space requirement for workspaces depends on whether the user databases are checked serially or concurrently. If **dbcc checkstorage** operations are run serially, the largest *scan* and *text* workspaces can be used for all user databases. If **dbcc checkstorage** operations are run concurrently, then *dbccdb* should be set to accommodate the largest workspaces that will be used concurrently. You can determine the workspace sizes by adding the sizes of the largest databases that will be checked concurrently.

For more information, see “dbccdb Workspaces” on page 12-13.

Configuring Adaptive Server for *dbcc checkstorage*

This section provides information on configuring Adaptive Server for **dbcc checkstorage**.

Configuring Worker Processes

The following parameters affect **dbcc checkstorage**:

- **max worker processes** – set this parameter with **sp_dbcc_updateconfig**. It updates the value of *max worker processes* in the *dbcc_config* table for each target database.
- **number of worker processes** – set this configuration parameter with **sp_configure**. It updates the *server_name.cfg* file.
- **memory per worker process** – set this configuration parameter with **sp_configure**. It updates the *server_name.cfg* file.

After changing the value of the **sp_configure** parameters, you must restart Adaptive Server for the change to take effect. For details, see Chapter 17, "Setting Configuration Parameters."

max worker processes specifies the maximum number of worker processes used by **dbcc checkstorage** for each target database, while **number of worker processes** specifies the total number of worker processes supported by Adaptive Server. Worker processes are not dedicated to running **dbcc checkstorage** operations.

Set the value for **number of worker processes** high enough to allow for the number of processes specified by **max worker processes**. A low number of worker processes reduces the performance and resource consumption of **dbcc checkstorage**. **dbcc checkstorage** will not use more processes than the number of database devices used by the database. Cache size, CPU performance, and device sizes might suggest a lower worker processes count. If there are not enough worker processes configured for Adaptive Server, **dbcc checkstorage** will not run.

maximum parallel degree and **maximum scan parallel degree** have no effect on the parallel functions of **dbcc checkstorage**. When **maximum parallel degree** is set to 1, parallelism in **dbcc checkstorage** is not disabled.

dbcc checkstorage requires multiple processes, so **number of worker processes** must be set to at least 1 to allow for a parent process and a worker process.

sp_plan_dbccdb recommends values for the number of worker processes, depending on database size, number of devices, and other factors. You can use smaller values to limit the load on your system. **dbcc checkstorage** may use fewer worker processes than **sp_plan_dbccdb** recommends or fewer than you configure.

Using more worker processes does not guarantee faster performance. The following scenario describes the effects of two different configurations:

An 8GB database has 4GB of data on disk A and 0.5GB of data on each of the disks B, C, D, E, F, G, H, and I.

With 9 worker processes active, the time it takes to run **dbcc checkstorage** is 2 hours, which is the time it takes to check disk A. Each of the other 8 worker processes finishes in 15 minutes and waits for the disk A worker process to finish.

With 2 worker processes active, the time it takes to run **dbcc checkstorage** is still 2 hours. The first worker process processes disk A and the other worker process processes disks B, C, D, E, F, G, H, and

I. In this case, there is no waiting, and resources are used more efficiently.

memory per worker process specifies the total memory allocation for worker processes support in Adaptive Server. The default value is adequate for **dbcc checkstorage**.

Setting Up a Named Cache for *dbcc*

If you use a named cache for **dbcc checkstorage**, you might need to adjust the Adaptive Server configuration parameters.

During a **dbcc checkstorage** operation, the workspaces are temporarily bound to a cache which is also used to read the target database. Using a named cache that is dedicated to **dbcc** minimizes the impact of the database check on other users and improves performance. You can create a separate cache for each **dbcc checkstorage** operation that will be run concurrently, or you can create one cache that is large enough to fit the total requirements of the concurrent operations. The size required for optimum performance depends on the size of the target database and distributions of data in that database. **dbcc checkstorage** requires a minimum of 640K of 16K buffers per worker process in the named cache.

For best performance, assign most of the dedicated cache to the 16K buffer pool and do not partition the cache. The recommended cache size is the minimum size for the 16K pool. Add the size of the 2K pool to this value.

If you dedicate a cache for **dbcc checkstorage**, the command does not require more than the minimum 2K buffer pool (0.5MB). If the cache is shared, you can improve the performance of **dbcc checkstorage** by increasing the 16K pool size before running the operation, and reducing the size after the operation is complete. The 16K pool requirements are the same for a shared cache. However, while a shared cache may meet the size requirement, other demands on the cache might limit the buffer availability to **dbcc checkstorage** and greatly impact the performance of both **checkstorage** and Adaptive Server as a whole.

◆ ***WARNING!***

Do not use cache partitions in a cache being used for dbcc checkstorage.

To configure Adaptive Server with a named cache for **dbcc checkstorage** operations, use **sp_cacheconfig** and **sp_poolconfig**. See Chapter 15, "Configuring Data Caches."

Configuring a 16K I/O buffer pool

dbcc checkstorage requires a 16K I/O buffer pool. Use **sp_poolconfig** to configure the pool size and verify that the pool has been configured properly. The pool size is stored in the *dbcc_config* table.

The following example shows how to use **sp_poolconfig** to set the 16K buffer pool for "master_cache," the named cache that was created for the *master* database.

```
1> sp_poolconfig "master_cache", "1024K", "16K"
2> go
(return status = 0)
```

The following example shows that the buffer pool for the private cache "master_cache" is set:

```
1> sp_poolconfig "master_cache"
2> go
Cache Name     Status    Type     Config Value Run Value
-------------  --------- -------- ------------ ------------
master_cache   Active    Mixed         2.00 Mb      2.00 Mb
                                    ------------ ------------
                         Total        2.00 Mb      2.00 Mb
===================================================================
Cache: master_cache,   Status: Active,   Type: Mixed
   Config Size: 2.00 Mb,   Run Size: 2.00 Mb
   Config Replacement: strict LRU,   Run Replacement: strict LRU
IO Size  Wash Size Config Size  Run Size     APF Percent
-------- --------- ------------ ------------ -----------
2 Kb     512 Kb    0.00 Mb      1.00 Mb      10
16 Kb    192 Kb    1.00 Mb      1.00 Mb      10
(return status = 0)
```

For more information on **sp_poolconfig**, see the *Adaptive Server Reference Manual*.

Allocating Disk Space for *dbccdb*

Additional disk storage is required for the *dbccdb* database. Because **dbcc checkstorage** uses *dbccdb* extensively, you should place *dbccdb* on a device that is separate from other database devices.

➤ ***Note***

Do not create *dbccdb* on the master device. Make sure that the log devices and data devices for *dbccdb* are separate.

Segments for Workspaces

By dedicating segments for workspaces, you can control the workspace placement and improve the performance of **dbcc checkstorage** performance. When you dedicate new segments for the exclusive use of workspaces, be sure to unmap the devices attached to these segments from the default segment with **sp_dropsegment**.

Creating the *dbccdb* Database

To create the *dbccdb* database:

1. Run **sp_plan_dbccdb** in the *master* database to obtain recommendations for database size, devices, workspace sizes, cache size, and the number of worker processes for the target database. For example, suppose you run **sp_plan_dbccdb** with *pubs2* as the target database when *dbccdb* did not exist:

   ```
   use master
   go

   sp_plan_dbccdb pubs2
   go
   ```

   The following output appears:

```
Recommended size for dbccdb is 4MB.

Recommended devices for dbccdb are:

Logical Device Name   Device Size   Physical Device Name

sprocdev              28672         /remote/SERV/sprocs_dat
tun_dat               8192          /remote/SERV/tun_dat
tun_log               4096          /remote/SERV/tun_log

Recommended values for workspace size, cache size and process
count are:

dbname        scan ws    text ws    cache    process count

pubs2         64K         64K        640K     1
```

For details on the information provided by **sp_plan_dbccdb**, see "Planning Resources" on page 25-31.

2. If *dbccdb* already exists, drop it and all associated devices before creating a new *dbccdb* database:

```
use master
go

if exists (select * from master.dbo.sysdatabases
     where name = "dbccdb")
begin
     print "+++ Dropping the dbccdb database"
     drop database dbccdb
end
go
```

3. Use **disk init** to initialize disk devices for the *dbccdb* data and the log:

```
use master
go

disk init
   name = "dbccdb_dat",
   physname = "/remote/disks/masters/",
   vdevno = 4,
   size = 4096
go

disk init
   name = "dbccdb_log",
   physname = "/remote/disks/masters/",
   vdevno = 5,
   size = 1024
go
```

4. Use **create database** to create *dbccdb* on the data disk device that you initialized in step 3:

```
use master
go

create database dbccdb
   on dbccdb_dat = 6
   log on dbccdb_log = 2
go
```

5. (Optional) – add segments for the *scan* and *text* workspaces to the *dbccdb* data device:

```
use dbccdb
go
```

```
sp_addsegment scanseg, dbccdb, dbccdb_dat
go

sp_addsegment textseg, dbccdb, dbccdb_dat
go
```

6. Create the tables for *dbccdb* and initialize the *dbcc_types* table:

   ```
   isql -Ujms -P***** -iinstalldbccdb
   ```

   The **installdbccdb** script checks for the existence of the database before it attempts to create the tables. It creates only those tables that do not already exist in *dbccdb*. If any of the *dbccdb* tables become corrupted, remove them with **drop table**, and then use **installdbccdb** to re-create them.

7. Create and initialize the *scan* and *text* workspaces:

   ```
   use dbccdb
   go

   sp_dbcc_createws dbccdb, scanseg, scan_pubs2,
   scan, "10M"
   go

   sp_dbcc_createws dbccdb, textseg, text_pubs2,
   text, "10M"
   go
   ```

When you have finished installing *dbccdb*, you must update the *dbcc_config* table.

Updating the *dbcc_config* Table

Use **sp_dbcc_updateconfig** to initialize the *dbcc_config* table for the **target database**. You must update each **dbcc** parameter separately for each target database, as shown in the following example.

```
use dbccdb
go

sp_dbcc_updateconfig pubs2,"max worker processes", "4"
go

sp_dbcc_updateconfig pubs2, "dbcc named cache", pubs2_cache, "10K"
go

sp_dbcc_updateconfig pubs2, "scan workspace", scan_pubs2
go

sp_dbcc_updateconfig pubs2, "text workspace", text_pubs2
```

```
go

sp_dbcc_updateconfig pubs2, "OAM count threshold", "5"
go

sp_dbcc_updateconfig pubs2, "IO error abort", "3"
go

sp_dbcc_updateconfig pubs2,"linkage error abort", "8"
go
```

You can now use **dbcc checkstorage** to check your databases. For descriptions of the **dbcc** parameters, see *type code* values 1 through 9 in "dbcc_types" on page 12-6.

Maintaining *dbccdb*

You will occasionally need to perform maintenance tasks on *dbccdb*.

- Reevaluate and update the configuration using:
  - **sp_dbcc_evaluatedb** – recommends values for configuration parameters using the results of previous **dbcc checkstorage** operations.
  - **sp_dbcc_updateconfig** – updates the configuration parameters for the specified database.
- Clean up obsolete data in *dbccdb*:
  - **sp_dbcc_deletedb** – deletes all the information on the specified database from *dbccdb*.
  - **sp_dbcc_deletehistory** – deletes the results of the **dbcc checkstorage** operations on the specified database from *dbccdb*.
- Remove unnecessary workspaces.
- Perform consistency checks on *dbccdb* itself.

The following sections describe the maintenance tasks in greater detail.

Reevaluating and Updating *dbccdb* Configuration

If the characteristics of user databases change, use **sp_dbcc_evaluatedb** to reevaluate the current *dbccdb* configuration and recommend more suitable values.

The following changes to user databases might affect the *dbccdb* configuration, as follows:

- When a user database is created, deleted or altered, the size of the workspaces and named cache, or the number of worker threads stored in the *dbcc_config* table might be affected.
- Changes in the named cache size or worker process count for **dbcc_checkstorage** may require you to reconfigure buffer cache and worker processes.

If the results of **dbcc checkstorage** operations are available for the target database, use **sp_dbcc_evaluatedb** to determine new configuration values. **sp_dbcc_configreport** also reports the configuration parameters for the specified database.

Use **sp_dbcc_updateconfig** to add new databases to the *dbcc_config* table and to change the configuration values in *dbcc_config* to reflect the values recommended by **sp_dbcc_evaluatedb**.

Cleaning Up *dbccdb*

Adaptive Server stores data generated by **dbcc checkstorage** in *dbccdb*. You should periodically clean up *dbccdb* by using **sp_dbcc_deletehistory** to delete data for the target database that was created before the date you specify.

When you delete a database, you should also delete from *dbccdb* all configuration information and **dbcc checkstorage** results related to that database. Use **sp_dbcc_deletedb** to delete all database information from *dbccdb*.

Removing Workspaces

You may need to remove unnecessary workspaces. In *dbccdb*, issue:

```
drop table workspace_name
```

Performing Consistency Checks on *dbccdb*

The limited update activity in the *dbccdb* tables should make corruption less frequent. Two signs of corruption in *dbccdb* are:

- Failure of **dbcc checkstorage** during the initialization phase, as it evaluates the work that needs to be performed, or during the completion phase, when it records its results
- Loss of information about faults resulting from corruption in the recorded faults, found by **dbcc checkstorage**

A severe corruption in *dbccdb* may cause **dbcc checkstorage** to fail. For **dbcc checkstorage** to locate severe corruptions in *dbccdb*, you can create an alternate database, *dbccalt*, which you use only for checking *dbccdb*. Create *dbccalt* using the same process that you used to create *dbccdb* as described in "Preparing to Use dbcc checkstorage" on page 25-29.

If no free devices are available for *dbccalt*, you can use any device that is not used by the *master* database or *dbccdb*.

dbcc checkstorage and the **dbcc** system procedures function the same with *dbccalt* as they do with *dbccdb*. When the target database is *dbccdb*, **dbcc checkstorage** uses *dbccalt*, if it exists. If *dbccalt* does not exist, *dbccdb* can be checked using itself as the management database. If the target database is *dbccdb* and *dbccalt* exists, the results of **dbcc checkstorage** operations on *dbccdb* are stored in *dbccalt*. If *dbccalt* does not exist, the results are stored in *dbccdb* itself.

Alternatively, **dbcc checkalloc** and **dbcc checktable** can be used to check *dbccdb*.

If *dbccdb* becomes corrupted, you can drop it and re-create it or load an older version from a backup. If you drop it, some of its diagnostic history will be lost.

Generating Reports from *dbccdb*

Several **dbcc** stored procedures are provided with *dbccdb* so that you can generate reports from the data in *dbccdb*.

To Report a Summary of *dbcc checkstorage* Operations

sp_dbcc_summaryreport reports all **dbcc checkstorage** operations that were completed for the specified database on or before the specified date. The following example shows output from this command:

```
sp_dbcc_summaryreport
```

```
DBCC Operation : checkstorage

Database Name      Start time           End Time   Operation ID
       Hard Faults Soft Faults Text Columns Abort Count
       User Name
------------------ ------------------- ---------- ------------
      ----------- ----------- ------------ -----------
      ------------------------------
sybsystemprocs     05/12/1997 10:54:45  10:54:53             1
                0           0            0           0
       sa
sybsystemprocs     05/12/1997 11:14:10  11:14:19             2
                 0           0            0           0
       sa
```

For details, see "dbcc Stored Procedures" in the *Adaptive Server Reference Manual*.

To Report Configuration, Statistics and Fault Information

sp_dbcc_fullreport runs these reports in the order shown:

- **sp_dbcc_summaryreport** – for an example, see "To Report a Summary of dbcc checkstorage Operations" on page 25-43.
- **sp_dbcc_configreport** – for an example, see "To See Configuration Information for a Target Database" on page 25-44.
- **sp_dbcc_statisticsreport** – for an example, see "To Report Statistics Information from dbcc_counter" on page 25-46.
- **sp_dbcc_faultreport short** – for an example, see "To Report Faults Found in a Database Object" on page 25-45.

To See Configuration Information for a Target Database

Use **sp_dbcc_configreport** to generate a report of the configuration information for a target database. The following example shows output from this command:

```
sp_dbcc_configreport
```

```
Reporting configuration information of database sybsystemprocs.

Parameter Name              Value                          Size

database name               sybsystemprocs                 51200K
dbcc named cache            default data cache             1024K
text workspace              textws_001 (id = 544004969)    128K
scan workspace              scanws_001 (id = 512004855)    1024K
max worker processes        1
operation sequence number   2
```

To Compare Results of *dbcc checkstorage* Operations

sp_dbcc_differentialreport compares the results of the **dbcc checkstorage** operations completed for the specified database object on the specified dates. The following example shows output from this command:

```
sp_dbcc_differentialreport master, sysprocedures,
checkstorage, "01/01/96", "01/02/96"
```

```
The following changes in dbcc counter values for the object
"sysprocedures" in database master have been noticed between
01/01/96 and 01/02/96.

Description        Date1   Date2

pages used          999    1020
pages reserved     1000    1024
page extent gaps     64      67
```

To Report Faults Found in a Database Object

sp_dbcc_faultreport reports faults in the specified database object that occurred on or before the specified date. You can generate a short or long report. The following example shows a short report:

```
sp_dbcc_faultreport 'short'
```

```
Database Name : sybsystemprocs

 Table Name     Index  Type Code Description         Page Number
 -------------- ------ --------- ------------------- -----------
 sysprocedures        0    100031 page not allocated        5702
 sysprocedures        1    100031 page not allocated       14151
 syslogs              0    100022 chain start error        24315
 syslogs              0    100031 page not allocated       24315
```

The following example shows part of the output of a long report for the *sybsystemprocs* database. The complete report repeats the information for each object in the target database.

```
sp_dbcc_faultreport 'long'
```

```
Generating 'Fault Report' for object sysprocedures in database
sybsystemprocs.

Type Code: 100031; Soft fault, possibly spurious
Page reached by the chain is not allocated.
page id:  14151
page header:
0x0000374700003788000037460000000500064 8B803EF0001000103FE0080000F
Header for 14151, next 14216, previous 14150, id = 5:1
 time stamp = 0x0001000648B8, next row = 1007, level = 0
 free offset = 1022, minlen = 15, status = 128(0x0080)
.
.
.
```

To Report Statistics Information from *dbcc_counter*

sp_dbcc_statisticsreport reports statistics information from the *dbcc_counter* table generated by **dbcc checkstorage** on or before the specified date. The following example shows output from this command:

```
sp_dbcc_statisticsreport 'sybsystemprocs',
'sysobjects'
```

```
Statistics Report on object sysobjects in database sybsystemprocs

 Parameter Name    Index Id Value
 ----------------- -------- -----------
 count             0        160.0
 max size          0        99.0
 max count         0        16.0
 bytes data        0        12829.0
 bytes used        0        15228.0
 count             1        16.0
 max size          1        9.0
 max level         1        0.0
 max count         1        16.0
 bytes data        1        64.0
 bytes used        1        176.0
 count             2        166.0
 max level         2        1.0
 max size          2        39.0
 max count         2        48.0
 bytes data        2        3092.0
```

```
bytes used        2        4988.0


Parameter Name          Index Id Partition Value    Dev_name
----------------------- -------- --------- -------- ----------------
page gaps               0        1         16.0     master
pages used              0        1         17.0     master
extents used            0        1         3.0      master
overflow pages          0        1         0.0      master
pages overhead          0        1         1.0      master
pages reserved          0        1         6.0      master
page extent gaps        0        1         7.0      master
ws buffer crosses       0        1         7.0      master
page extent crosses     0        1         7.0      master
page gaps               1        1         1.0      master
pages used              1        1         2.0      master
extents used            1        1         1.0      master
overflow pages          1        1         0.0      master
pages overhead          1        1         1.0      master
pages reserved          1        1         6.0      master
page extent gaps        1        1         0.0      master
ws buffer crosses       1        1         0.0      master
page extent crosses     1        1        0.0       master
page gaps               2        1         5.0      master
pages used              2        1         8.0      master
extents used            2        1         1.0      master
overflow pages          2        1         0.0      master
pages overhead          2        1         1.0      master
pages reserved          2        1         0.0      master
page extent gaps        2        1         0.0      master
ws buffer crosses       2        1         0.0      master
page extent crosses     2        1         0.0      master
```

Backup and Recovery

26 Developing a Backup and Recovery Plan

Adaptive Server has **automatic recovery** procedures that protect you from power outages and computer failures. To protect yourself against media failure, you must make regular and frequent backups of your databases.

This chapter provides information to help you develop a backup and recovery plan. It includes the following topics, which provide an overview of Adaptive Server's backup and recovery processes:

This chapter also discusses the backup and recovery issues that you should address before you begin using your system for production, including:

Keeping Track of Database Changes

Adaptive Server uses transactions to keep track of all database changes. Transactions are Adaptive Server's units of work. A transaction consists of one or more Transact-SQL statements that succeed—or fail—as a unit.

Each SQL statement that modifies data is considered a **transaction**. Users can also define transactions by enclosing a series of statements within a **begin transaction...end transaction** block. For more information about transactions, see Chapter 18, "Transactions: Maintaining Data Consistency and Recovery," in the *Transact-SQL User's Guide*.

Each database has its own **transaction log**, the system table *syslogs*. The transaction log automatically records every transaction issued by each user of the database. You cannot turn off transaction logging.

The transaction log is a **write-ahead log**. When a user issues a statement that will modify the database, Adaptive Server writes the changes to the log. After all changes for a statement have been recorded in the log, they are written to an in-cache copy of the data page. The data page remains in cache until the memory is needed for another database page. At that time, it is written to disk.

If any statement in a transaction fails to complete, Adaptive Server reverses all changes made by the transaction. Adaptive Server writes an "end transaction" record to the log at the end of each transaction, recording the status (success or failure) of the transaction.

Getting Information About the Transaction Log

The transaction log contains enough information about each transaction to ensure that it can be recovered. Use the **dump transaction** command to copy the information it contains to tape or disk. Use **sp_spaceused syslogs** to check the size of the log, or **sp_helpsegment logsegment** to check the space available for log growth.

◆ ***WARNING!***

Never use insert, update, or delete commands to modify *syslogs*.

Synchronizing a Database and Its Log: Checkpoints

A checkpoint writes all dirty pages—pages that have been modified in memory, but not on disk, since the last checkpoint—to the

database device. Adaptive Server's automatic **checkpoint** mechanism guarantees that data pages changed by completed transactions are regularly written from the memory cache to the database device. Synchronizing the database and its transaction log shortens the time it takes to recover the database after a system crash.

Setting the Recovery Interval

Typically, automatic recovery takes from a few seconds to a few minutes per database. The time varies, depending on the size of the database, the size of the transaction log, and the number and size of the transactions that must be committed or rolled back.

Use sp_configure with the **recovery interval in minutes** parameter to specify, the maximum permissible recovery time. Adaptive Server runs automatic checkpoints often enough to recover the database within that period of time.

```
sp_configure "recovery interval in minutes"
```

The default value, 5, allows recovery within 5 minutes per database. To change the recovery interval to 3 minutes, use:

```
sp_configure "recovery interval in minutes", 3
```

➤ ***Note***

The recovery interval has no effect on long-running, minimally logged transactions (such as **create index**) that are active at the time Adaptive Server fails. It may take as much time to reverse these transactions as it took to run them. To avoid lengthy delays, dump each database immediately after you create an index on one of its tables.

Automatic Checkpoint Procedure

Approximately once a minute, the checkpoint task checks each database on the server to see how many records have been added to the transaction log since the last checkpoint. If the server estimates that the time required to recover these transactions is greater than the database's recovery interval, Adaptive Server issues a checkpoint.

The modified pages are written from cache onto the database devices, and the checkpoint event is recorded in the transaction log. Then, the checkpoint task "sleeps" for another minute.

To see the checkpoint task, execute **sp_who**. The checkpoint task is usually displayed as "CHECKPOINT SLEEP" in the "cmd" column:

```
spid  status     loginame   hostname blk dbname  cmd
----- ---------- ---------- -------- --- ------- ----------------
    1 running    sa         mars     0   master  SELECT
    2 sleeping   NULL                0   master  NETWORK HANDLER
    3 sleeping   NULL                0   master  MIRROR HANDLER
    4 sleeping   NULL                0   master  HOUSEKEEPER
    5 sleeping   NULL                0   master  CHECKPOINT SLEEP
```

Checkpoint After User Database Upgrade

Adaptive Server inserts a checkpoint record immediately after upgrading a user database. Adaptive Server uses this record to ensure that a **dump database** occurs before a **dump transaction** occurs on the upgraded database.

Truncating the Log After Automatic Checkpoints

System Administrators can truncate the transaction log when Adaptive Server performs an automatic checkpoint.

To set the **trunc log on chkpt** database option, which will truncate the transaction log if it consists of 50 or more rows when an automatic checkpoint occurs, execute this command from the *master* database:

```
sp_dboption database_name, "trunc log on chkpt",
true
```

This option is not suitable for production environments because it does not make a copy of the transaction log before truncating it. Use **trunc log on chkpt** only for:

- Databases whose transaction logs cannot be backed up because they are not on a separate segment
- Test databases for which current backups are not important

➤ ***Note***

If you leave the **trunc log on chkpt** option set to **off** (the default condition), the transaction log continues to grow until you truncate it with the **dump transaction** command.

To protect your log from running out of space, you should design your last-chance threshold procedure to dump the transaction log.

For more information about threshold procedures, see Chapter 29, "Managing Free Space with Thresholds."

Free Checkpoints

When Adaptive Server has no user tasks to process, a housekeeper task automatically begins writing dirty buffers to disk. If the housekeeper task is able to flush all active buffer pools in all configured caches, it wakes up the checkpoint task. The checkpoint task determines whether it needs to perform a checkpoint on the database.

Checkpoints that occur as a result of the housekeeper task are known as **free checkpoints**. They do not involve writing many dirty pages to the database device, since the housekeeper task has already done this work. They may result in a shorter recovery time for the database.

For information about tuning the housekeeper task, see Chapter 37, "How Adaptive Server Uses Engines and CPUs," in the *Performance and Tuning Guide*.

Manually Requesting a Checkpoint

Database Owners can issue the **checkpoint** command to force all modified pages in memory to be written to disk. Manual checkpoints do not truncate the log, even if the **trunc log on chkpt** option of **sp_dboption** is turned on.

Use the **checkpoint** command:

- As a precautionary measure in special circumstances—for example, just before a planned **shutdown with nowait** so that Adaptive Server's recovery mechanisms will occur within the recovery interval. (An ordinary **shutdown** performs a checkpoint.)
- To cause a change in database options to take effect after executing the **sp_dboption** system procedure. (After you run **sp_dboption**, an informational message reminds you to run **checkpoint**.)

Automatic Recovery After a System Failure or Shutdown

Each time you restart Adaptive Server—for example, after a power failure, an operating system failure, or the use of the **shutdown**

command—it automatically performs a set of recovery procedures on each database.

The recovery mechanism compares each database to its transaction log. If the log record for a particular change is more recent than the data page, the recovery mechanism reapplies the change from the transaction log. If a transaction was ongoing at the time of the failure, the recovery mechanism reverses all changes that were made by the transaction.

When you boot Adaptive Server, it performs database recovery in this order:

1. Recovers *master*
2. Recovers *model*
3. Creates *tempdb* (by copying *model*)
4. Recovers *sybsystemdb*
5. Recovers *sybsecurity*
6. Recovers *sybsystemprocs*
7. Recovers user databases, in order by *sysdatabases.dbid*, or according to the order specified by **sp_dbrecovery_order**. See below for more information about **sp_dbrecovery_order**.

Users can log in to Adaptive Server as soon as the system databases have been recovered, but they cannot access other databases until they have been recovered.

Determining Whether Messages Are Displayed During Recovery

The configuration variable **print recovery information** determines whether Adaptive Server displays detailed messages about each transaction on the console screen during recovery. By default, these messages are not displayed. To display messages, use:

```
sp_configure "print recovery information", 1
```

User-Defined Database Recovery Order

sp_dbrecovery_order allows you to determine the order in which individual user databases recover. This makes it possible to assign a recovery order in which, for example, critical databases recover before lower-priority databases.

Important features of recovery order are:

- System databases are recovered first, in this order:
  - *master*
  - *model*
  - *tempdb*
  - *sybsystemdb*
  - *sybsecurity*
  - *sybsystemprocs*

  All other databases are considered user databases, and you can specify their recovery order.
- You can use **sp_dbrecovery_order** to specify the recovery order of user-databases and to list the user-defined recovery order of an individual database or of all databases.
- User databases that are not explicitly assigned a recovery order with **sp_dbrecovery_order** are recovered according to their database ID, after all the databases that have a user-defined recovery order.
- If you do not use **sp_dbrecovery_order** to assign any databases a recovery order, user databases are recovered in order of database ID.

Using *sp_dbrecovery_order*

To use **sp_dbrecovery_order** to enter or modify a user-defined recovery order, you must be in the *master* database and have System Administrator privileges. Any user, in any database, can use **sp_dbrecovery_order** to list the user-defined recovery order of databases.

The syntax for **sp_dbrecovery_order** is:

```
sp_dbrecovery_order
   [database_name [, rec_order [, force]]]
```

where *database_name* is the name of the user database to which you want to assign a recovery order, and *rec_order* is the order in which the database is to be recovered.

Recovery order must be consecutive, starting with 1. You cannot assign a recovery sequence of 1, 2, 4, with the intention of assigning a recovery order of 3 to another database at a later time.

To insert a database into a user-defined recovery sequence without putting it at the end, enter *rec_order* and specify **force**. For example, if

databases *A*, *B*, and *C* have a user-defined recovery order of 1, 2, 3, and you want to insert the *pubs2* database as the second user database to recover, enter:

```
sp_dbrecovery_order pubs2, 2, force
```

This command assigns a recovery order of 3 to database *B* and a recovery order of 4 to database C.

Changing or Deleting the Recovery Position of a Database

To change the position of a database in a user-defined recovery sequence, delete the database from the recovery sequence and then insert it in the position you want it to occupy. If the new position is not at the end of the recovery order, use the **force** option.

To delete a database from a recovery sequence, specify a recovery order of -1.

For example, to move the *pubs2* database from recovery position 2 to recovery position 1, delete the database from the recovery sequence and then reassign it a recovery order as follows:

```
sp_dbrecovery_order pubs2, -1
sp_dbrecovery_order pubs2, 1, "force"
```

Listing the User-Assigned Recovery Order of Databases

To list the recovery order of all databases assigned a recovery order, use:

```
sp_dbrecovery_order
```

This generates output similar to:

```
The following databases have user specified
recovery order:
Recovery Order Database Name        Database Id
-------------- -------------------- -----------
    1          dbccdb                    8
    2          pubs2                     5
    3          pubs3                     6
    4          pubtune                   7
The rest of the databases will be recovered in
default database id order.
```

To display the recovery order of a specific database, enter the database name:

```
1> sp_dbrecovery_order pubs2
2> go
Database Name Database id Recovery Order
 ------------- ----------- --------------
 pubs2             5          2
```

Fault Isolation During Recovery

The recovery procedures, known simply as "recovery," rebuild the server's databases from the transaction logs. The following situations cause recovery to run:

- Adaptive Server start-up
- Use of the **load database** command
- Use of the **load transaction** command

The recovery isolation mode setting controls how recovery behaves when it detects corrupt data while reversing or reapplying a transaction in a database.

If an index is marked as suspect, the System Administrator can repair this by dropping and re-creating the index.

Recovery fault isolation provides the ability to:

- Configure whether an entire database or just the suspect pages become inaccessible when recovery detects corruption
- Configure whether an entire database with suspect pages comes online in **read_only** mode or whether the online pages are accessible for modification
- List databases that have suspect pages
- List the suspect pages in a specified database by page ID, index ID, and object name
- Bring suspect pages online for the System Administrator while they are being repaired
- Bring suspect pages online for all database users after they have been repaired

The ability to isolate only the suspect pages while bringing the rest of the database online provides a greater degree of flexibility in dealing with data corruption. You can diagnose problems, and sometimes correct them, while most of the database is accessible to users. You can assess the extent of the damage and schedule emergency repairs or reload for a convenient time.

Recovery fault isolation applies only to user databases. Recovery always takes a system database entirely offline if it has any corrupt pages. You cannot recover a system database until you have repaired or removed all of its corrupt pages.

Persistence of Offline Pages

Suspect pages that you have taken offline remain offline when you reboot the server. Information about offline pages is stored in *master.dbo.sysattributes*.

Use the **drop database** and **load database** commands to clear entries for suspect pages from *master.dbo.sysattributes*.

Configuring Recovery Fault Isolation

When Adaptive Server is installed, the default recovery isolation mode is "databases," which marks a database as suspect and takes the entire database offline if it detects any corrupt pages.

Isolating Suspect Pages

To isolate the suspect pages so that only they are taken offline, while the rest of the database remains accessible to users, use the **sp_setsuspect_granularity** to set the recovery isolation mode to "page." This mode will be in effect the next time that recovery is performed in the database.

The syntax for **sp_setsuspect_granularity** is:

```
sp_setsuspect_granularity
   [dbname [,{"database" | "page"} [, "read_only"]]]
```

With the *dbname* and either **database** or **page** as the second argument, **sp_setsuspect_granularity** sets the recovery isolation mode.

Without the **database** or **page** argument, **sp_setsuspect_granularity** displays the current and configured recovery isolation mode settings for the specified database. Without any arguments, it displays those settings for the current database.

If corruption cannot be isolated to a specific page, recovery marks the entire database as suspect, even if you set the recovery isolation mode to "page." For example, a corrupt transaction log or the unavailability of a global resource causes this to occur.

When recovery marks specific pages as suspect, the default behavior is for the database to be accessible for reading and writing with the suspect pages offline and therefore inaccessible. However, if you specify the **read_only** option to **sp_setsuspect_granularity**, and recovery marks any pages as suspect, the entire database comes online in **read_only** mode and cannot be modified. If you prefer the **read_only** option, but in certain cases you are comfortable allowing users to modify the non-suspect pages, you can make the online portion of the database writable with **sp_dboption**:

```
sp_dboption pubs2, "read only", false
```

In this case, the suspect pages remain offline until you repair them or force them, as described in "Bringing Offline Pages Online" on page 26-13.

Raising the Number of Suspect Pages Allowed

The suspect escalation threshold is the number of suspect pages at which recovery marks an entire database suspect, even if the recovery isolation mode is "page." By default, it is set to 20 pages in a single database. You can use **sp_setsuspect_threshold** to change the suspect escalation threshold.

The syntax for **sp_setsuspect_threshold** is:

```
sp_setsuspect_threshold [dbname [,threshold]]
```

With the *dbname* and *threshold* arguments, **sp_setsuspect_threshold** displays the current and configured suspect escalation threshold settings for the specified database. Without any arguments, it displays these settings for the current database.

You configure recovery fault isolation and the suspect escalation threshold at the database level.

You cannot execute **sp_setsuspect_granularity** or **sp_setsuspect_threshold** inside a transaction.

You must have the **sa_role** and be in the *master* database to set values with **sp_setsuspect_granularity** and **sp_setsuspect_threshold**. Any user can execute these procedures with only the name of the database as an argument to display the values configured for that database, as illustrated below:

```
sp_setsuspect_granularity pubs2
DB Name  Cur. Suspect Gran.  Cfg. Suspect Gran.  Online mode
-------  ------------------  ------------------  -----------
pubs2    page                page                read/write
```

```
sp_setsuspect_threshold pubs2
DB Name       Cur. Suspect threshold   Cfg. Suspect threshold
------------- ----------------------- ----------------------
pubs2         20                      30
```

This example shows that the recovery isolation mode for the *pubs2* database was "page" and the escalation threshold was 20 the last time recovery ran on this database (the current suspect threshold values). The next time recovery runs on this database, the recovery isolation mode will be "page" and the escalation threshold will be 30 (the configured values).

With no arguments, **sp_setsuspect_granularity** and **sp_setsuspect_threshold** display the current and configured settings for the current database, if it is a user database.

Getting Information About Offline Databases and Pages

To see which databases have offline pages, use **sp_listsuspect_db**. The syntax is:

sp_listsuspect_db

The following example displays general information about the suspect pages:

```
sp_listsuspect_db
The database 'dbt1' has 3 suspect pages belonging to 2 objects.
(return status = 0)
```

To get detailed information about the individual offline pages, use **sp_listsuspect_page**. The syntax is:

sp_listsuspect_page [*dbname*]

If you don't specify the *dbname*, the defaults is the current database. The following example shows the detailed page-level output of **sp_listsuspect_page** in the *dbt1* database.

```
sp_listsuspect_page dbt1
DBName   Pageid       Object    Index   Access
-------- ------------ --------- ------- -------------------
dbt1     384          tab1      0       BLOCK_ALL
dbt1     390          tab1      0       BLOCK_ALL
dbt1     416          tab1      1       SA_ONLY

(3 rows affected, return status = 0)
```

If the value in the "Access" column is SA_ONLY, the suspect page is 1, the suspect page is accessible to users with the **sa_role**. If it is BLOCK_ALL, no one can access the page.

Any user can run **sp_listsuspect_db** and **sp_listsuspect_page** from any database.

Bringing Offline Pages Online

To make all the offline pages in a database accessible, use **sp_forceonline_db**. The syntax is:

```
sp_forceonline_db dbname,
   {"sa_on" | "sa_off" | "all_users"}
```

To make an individual offline page accessible, use **sp_forceonline_page**. The syntax is:

```
sp_forceonline_page dbname, pgid
   {"sa_on" | "sa_off" | "all_users"}
```

With both of these procedures, you specify the type of access.

- "**sa_on**" makes the suspect page or database accessible only to users with the **sa_role**. This is useful for repairing the suspect pages and testing the repairs while the database is up and running, without allowing normal users access to the suspect pages. You can also use it to perform a **dump database** or a **dump transaction with no_log** on a database with suspect pages, which would be prohibited if the pages were offline.
- "**sa_off**" blocks access to all users, including System Administrators. This reverses a previous **sp_forceonline_db** or **sp_forceonline_page** with "**sa_on**."
- "**all_users**" brings offline pages online for all users after the pages have been repaired.

  Unlike bringing suspect pages online with "**sa_on**" and then making them offline again with "**sa_off**," when you use **sp_forceonline_page** or **sp_forceonline_db** to bring pages online for "all users," this action cannot be reversed. There is no way to make the online pages offline again.

◆ ***WARNING!***

Adaptive Server does not perform any checks on pages being brought online. It is your responsibility to ensure that pages being brought online have been repaired.

You cannot execute **sp_forceonline_db** or **sp_forceonline_page** inside a transaction.

You must have the **sa_role** and be in the *master* database to execute **sp_forceonline_db** and **sp_forceonline_page**.

Index-Level Fault Isolation for Data-Only-Locked Tables

When pages of an index for a data-only-locked table are marked as suspect during recovery, the entire index is taken offline. Two system procedures manage offline indexes:

- **sp_listsuspect_object**
- **sp_forceonline_object**

In most cases, a System Administrator uses **sp_forceonline_object** to make a suspect index available only to those with the **sa_role**. If the index is on a user table, you can repair the suspect index by dropping and re-creating the index.

See the *Adaptive Server Reference Manual* for more information about **sp_listsuspect_objec** and **sp_forceonline_object**.

Side Effects of Offline Pages

The following restrictions apply to databases with offline pages:

- Transactions that need offline data, either directly or indirectly (for example, because of referential integrity constraints), fail and generate a message.
- You cannot use **dump database** when any part of the database is offline.

  A System Administrator can force the offline pages online using **sp_forceonline_db** with **"sa_on,"** dump the database, and then use **sp_forceonline_db** with **"sa_off"** after the dump completes.
- You cannot use **dump transaction with no_log** or **dump transaction with truncate_only** if any part of a database is offline.

A System Administrator can force the offline pages online using **sp_forceonline_db** with **"sa_on,"**, dump the transaction log using **with no_log**, and then use **sp_forceonline_db** with **"sa_off"** after the dump completes.

- If you want to drop a table or index containing offline pages, you must use a transaction in the *master* database. Otherwise, the drop will fail because it needs to delete entries for the suspect pages from *master.dbo.sysattributes*. The following example drops the object and deletes information about its offline pages from *master.dbo.sysattributes*.

  To drop an index named *authors_au_id_ind*, which contains suspect pages, from the *pubs2* database, drop the index inside a *master* database transaction as follows:

```
use master
go
sp_dboption pubs2, "ddl in tran", true
go
use pubs2
go
checkpoint
go
begin transaction
drop index authors.au_id_ind
commit
go
use master
go
sp_dboption pubs2, "ddl in tran", false
go
use pubs2
go
checkpoint
go
```

Recovery Strategies Using Recovery Fault Isolation

There are two major strategies for returning a database with suspect pages to a consistent state while users are accessing it: reload and repair.

Both strategies require:

- A clean database dump
- A series of reliable transaction log dumps up to the point at which the database is recovered with suspect pages

- A transaction log dump to a device immediately after the database is recovered to capture changes to the offline pages
- Continuous transaction log dumps to devices while users work in the partially offline database

Reload Strategy

Reloading involves restoring a clean database from backups. When convenient, load the most recent clean database dump, and apply the transaction logs to restore the database.

load database clears the suspect page information from the *master.dbo.sysdatabases* and *master.dbo.sysattributes* system tables.

When the restored database is online, dump the database immediately.

Figure 26-1 illustrates the strategy used to reload databases.

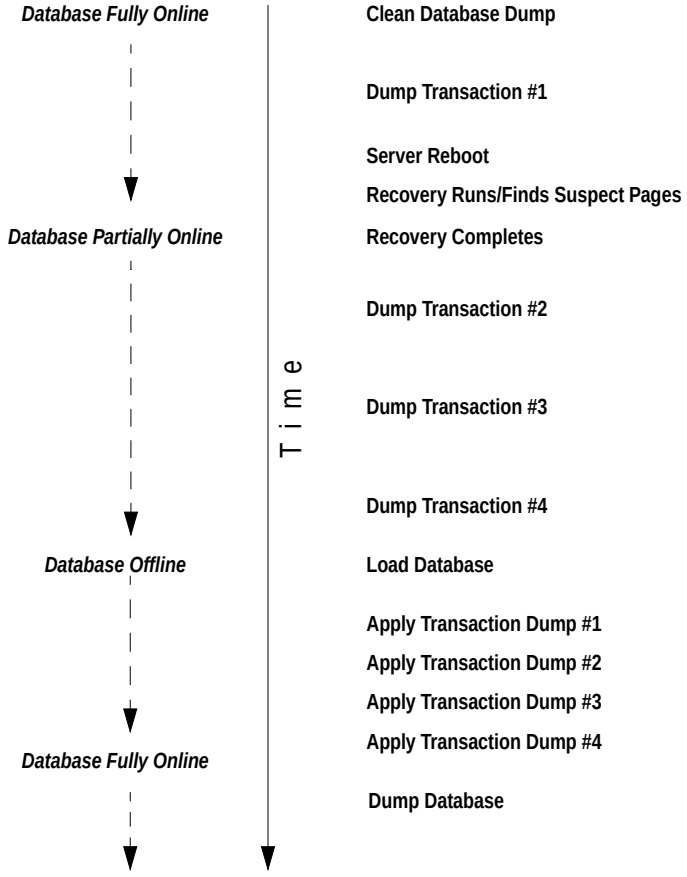


Figure 26-1: Reload strategy

Repair Strategy

The repair strategy involves repairing the corrupt pages while the database is partially offline. You diagnose and repair problems using known methods, including **dbcc** commands, running queries with known results against the suspect pages, and calling Sybase Technical Support, if necessary. Repairing damage can also include dropping and re-creating objects that contain suspect pages.

You can either use **sp_forceonline_page** to bring offline pages online individually, as they are repaired, or wait until all the offline pages are repaired and bring them online all at once with **sp_forceonline_db**.

The repair strategy does not require taking the entire database offline. Figure 26-2 illustrates the strategy used to repair corrupt pages.

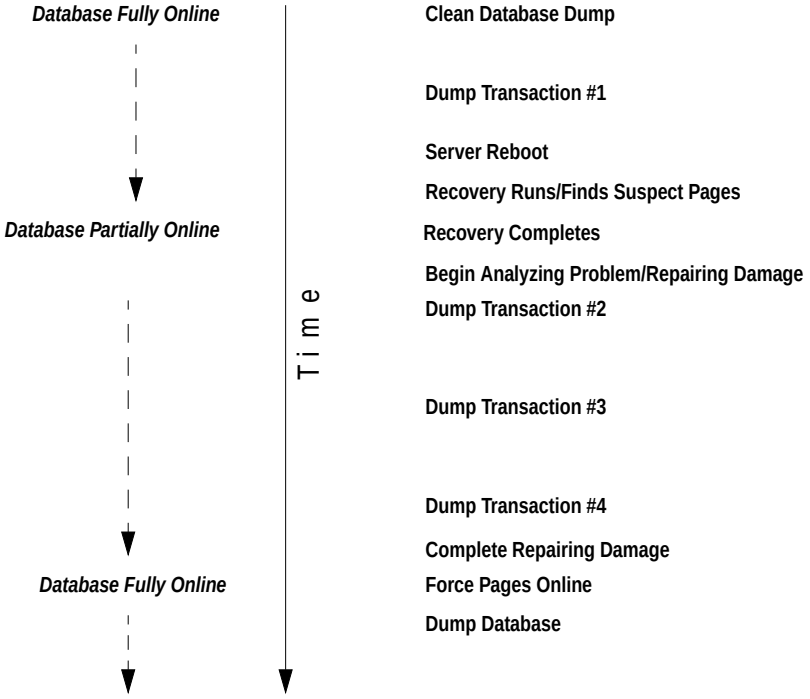


Figure 26-2: Repair strategy

Assessing the Extent of Corruption

You can sometimes use recovery fault isolation to assess the extent of corruption by forcing recovery to run and examining the number of pages marked suspect and the objects to which they belong.

For example, if users report problems in a particular database, set the recovery isolation mode to "page," and force recovery by restarting Adaptive Server. When recovery completes, use **sp_listsuspect_db** or **sp_listsuspect_page** to determine how many pages are suspect and which database objects are affected.

If the entire database is marked suspect and you receive the message:

```
Reached suspect threshold '%d' for database
'%.*s'. Increase suspect threshold using
sp_setsuspect_threshold.
```

use **sp_setsuspect_threshold** to raise the suspect escalation threshold and force recovery to run again. Each time you get this message, you can raise the threshold and run recovery until the database comes online. If you do not get this message, the corruption is not isolated to specific pages, in which case this strategy for determining the number of suspect pages will not work.

Using the Dump and Load Commands

In case of media failure, such as a disk crash, you can restore your databases if—and only if—you have regular backups of the databases and their transaction logs. Full recovery depends on the regular use of the **dump database** and **dump transaction** commands to back up databases and the **load database** and **load transaction** commands to restore them. These commands are described briefly below and more fully in Chapter 27, "Backing Up and Restoring User Databases," and Chapter 28, "Restoring the System Databases."

◆ ***WARNING!***

Never use operating system copy commands to copy a database device. Loading the copy into Adaptive Server causes massive database corruption.

The dump commands can complete successfully even if your database is corrupt. Before you back up a database, use the **dbcc** commands to check its consistency. See Chapter 25, "Checking Database Consistency," for more information.

Making Routine Database Dumps: *dump database*

The **dump database** command makes a copy of the entire database, including both the data and the transaction log. **dump database** does **not** truncate the log.

dump database allows **dynamic dumps**. Users can continue to make changes to the database while the dump takes place. This makes it convenient to back up databases on a regular basis.

dump database executes in three phases. A progress message informs you when each phase completes. When the dump is finished, it reflects all changes that were made during its execution, except for those initiated during phase 3.

Making Routine Transaction Log Dumps: *dump transaction*

Use the **dump transaction** command (or its abbreviation, **dump tran**) to make routine backups of your transaction log. **dump transaction** is similar to the incremental backups provided by many operating systems. It copies the transaction log, providing a record of any database changes made since the last database or transaction log dump. After **dump transaction** has copied the log, it truncates the inactive portion.

dump transaction takes less time and storage space than a full database backup, and it is usually run more often. Users can continue to make changes to the database while the dump is taking place. You can run **dump transaction** only if the database stores its log on a separate segment.

After a media failure, use the **with no_truncate** option of **dump transaction** to back up your transaction log. This provides a record of the transaction log up to the time of the failure.

Copying the Log After Device Failure: *dump tran with no_truncate*

If your data device fails and the database is inaccessible, use the **with no_truncate** option of **dump transaction** to get a current copy of the log. This option does not truncate the log. You can use it only if the transaction log is on a separate segment and the *master* database is accessible.

Restoring the Entire Database: *load database*

Use the **load database** command to load the backup created with **dump database**. You can load the dump into a preexisting database or create a new database with the **for load** option. When you create a new database, allocate at least as much space as was allocated to the original database.

◆ ***WARNING!***

You cannot load a dump that was made on a different platform or generated on per-version 10.0 SQL Server. If the database you are loading includes tables that contain the primary keys for tables in other databases, you must load the dump into a database with the same database name as the one dumped.

The **load database** command sets the database status to "offline." This means you do not have to use the **no chkpt on recovery, dbo use only,** and **read only** options of **sp_dboption** before you load a database. However, no one can use a database during the database load and subsequent transaction log loads. To make the database accessible to users, issue the **online database** command.

After the database is loaded, Adaptive Server may need to:

- "Zero" all unused pages, if the database being loaded into is larger than the dumped database.
- Complete recovery, applying transaction log changes to the data.

Depending on the number of unallocated pages or long transactions, this can take a few seconds or many hours for a very large database. Adaptive Server issues messages that it is "zero-ing" pages or has begun recovery. These messages are normally buffered; to see them, issue:

```
set flushmessage on
```

Applying Changes to the Database: *load transaction*

After you have loaded the database, use the **load transaction** command (or its abbreviation, **load tran**) to load each transaction log dump **in the order in which it was made**. This process reconstructs the database by re-executing the changes recorded in the transaction log. If necessary, you can recover a database by rolling it forward to a particular time in its transaction log, using the **until_time** option of **load transaction**.

Users cannot make changes to the database between the **load database** and **load transaction** commands, due to the "offline" status set by **load database**.

You can load only the transaction log dumps that are at the same release level as the associated database.

When the entire sequence of transaction log dumps has been loaded, the database reflects all transactions that had committed at the time of the last transaction log dump.

Making the Database Available to Users: *online database*

When the load sequence completes, change the database status to "online," to make it available to users. A database loaded by **load database** remains inaccessible until you issue the **online database** command is issued.

Before you issue this command, be sure you have loaded all required transaction logs.

Moving a Database to Another Adaptive Server

You can use **dump database** and **load database** to move a database from one Adaptive Server to another, as long as both Adaptive Servers run on the same hardware and software platform. However, you must ensure that the device allocations on the target Adaptive Server match those on the original. Otherwise, system and user-defined segments in the new database will not match those in the original database.

To preserve device allocations when loading a database dump into a new Adaptive Server, use the same instructions as for recovering a user database from a failed device. See "Examining the Space Usage" on page 27-46 for more information.

Also, follow these general guidelines when moving system databases to different devices:

- Before moving the *master* database, always unmirror the master device. If you do not, Adaptive Server will try to use the old mirror device file when you start Adaptive Server with the new device.
- When moving the *master* database, use a new device that is the same size as the original to avoid allocation errors in *sysdevices*.
- To move the *sybsecurity* database, place the new database in single-user mode before loading the old data into it.

Upgrading a User Database

You can load dumps into the current release of Adaptive Server from any version of Adaptive Server that is at version 10.0 and later. The loaded database is not upgraded until you issue **online database**.

The steps for upgrading user databases are the same as for system databases:

1. Use **load database** to load a database dump of a release 10.0 or later Adaptive Server. **load database** sets the database status to "offline."
2. Use **load transaction** to load, **in order**, all transaction logs generated after the last database dump. Be sure you have loaded all transaction logs before going to step 3.
3. Use **online database** to upgrade the database. The **online database** command upgrades the database because its present state is incompatible with the current release of Adaptive Server. When the upgrade completes, the database status is set to "online," which makes the database available for public use.
4. Make a dump of the upgraded database. A **dump database** must occur before a **dump transaction** command is permitted.

For more information about **load database**, **load transaction**, and **online database**, see the *Adaptive Server Reference Manual*.

Using the Special *dump transaction* Options

In certain circumstances, the simple model described above does not apply. Table 26-1 describes when to use the special **with no_log** and **with truncate_only** options instead of the standard **dump transaction** command.

◆ ***WARNING!***

Use the special dump transaction commands only as indicated in Table 26-1. In particular, use dump transaction with no_log as a last resort and use it only once after dump transaction with no_truncate fails. The dump transaction with no_log command frees very little space in the transaction log. If you continue to load data after entering dump transaction with no_log, the log may fill completely, causing any further dump transaction commands to fail. Use the alter database command to allocate additional space to the database.

Table 26-1: When to use dump transaction with truncate_only or with no_log

When	Use
The log is on the same segment as the data.	**dump transaction with truncate_only** to truncate the log **dump database** to copy the entire database, including the log
You are not concerned with the recovery of recent transactions (for example, in an early development environment).	**dump transaction with truncate_only** to truncate the log **dump database** to copy the entire database
Your usual method of dumping the transaction log (either the standard **dump transaction** command or **dump transaction with truncate_only**) fails because of insufficient log space.	**dump transaction with no_log** to truncate the log without recording the event **dump database** immediately afterward to copy the entire database, including the log

Using the Special Load Options to Identify Dump Files

Use the **with headeronly** option to provide header information for a specified file or for the first file on a tape. Use the **with listonly** option to return information about all files on a tape. These options do not actually load databases or transaction logs on the tape.

➤ ***Note***

These options are mutually exclusive. If you specify both, **with listonly** prevails.

Restoring a Database from Backups

Figure 26-3 illustrates the process of restoring a database that is created at 4:30 p.m. on Monday and dumped immediately afterward. Full database dumps are made every night at 5:00 p.m.

Transaction log dumps are made at 10:00 a.m., 12:00 p.m., 2:00 p.m., and 4:00 p.m. every day:

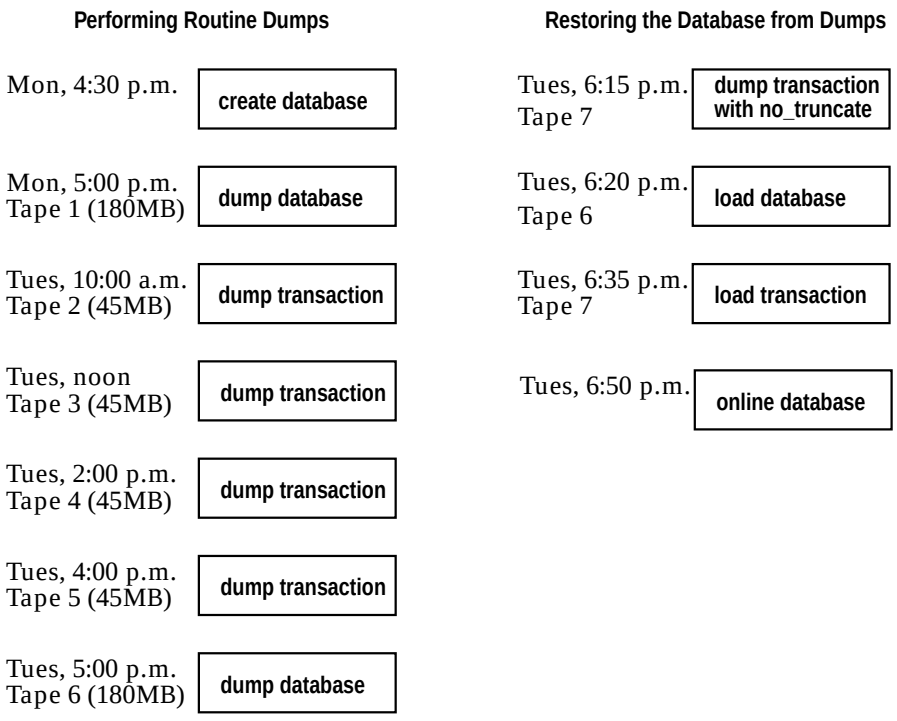


Figure 26-3: Restoring a database, a scenario

If the disk that stores the data fails on Tuesday at 6:00 p.m., follow these steps to restore the database:

1. Use **dump transaction with no_truncate** to get a current transaction log dump.
2. Use **load database** to load the most recent database dump, Tape 6. **load database** sets the database status to "offline."
3. Use **load transaction** to apply the most recent transaction log dump, Tape 7.
4. Use **online database** to set the database status to "online."

Figure 26-4 illustrates how to restore the database when the data device fails at 4:59 p.m. on Tuesday—just before the operator is scheduled to make the nightly database dump:

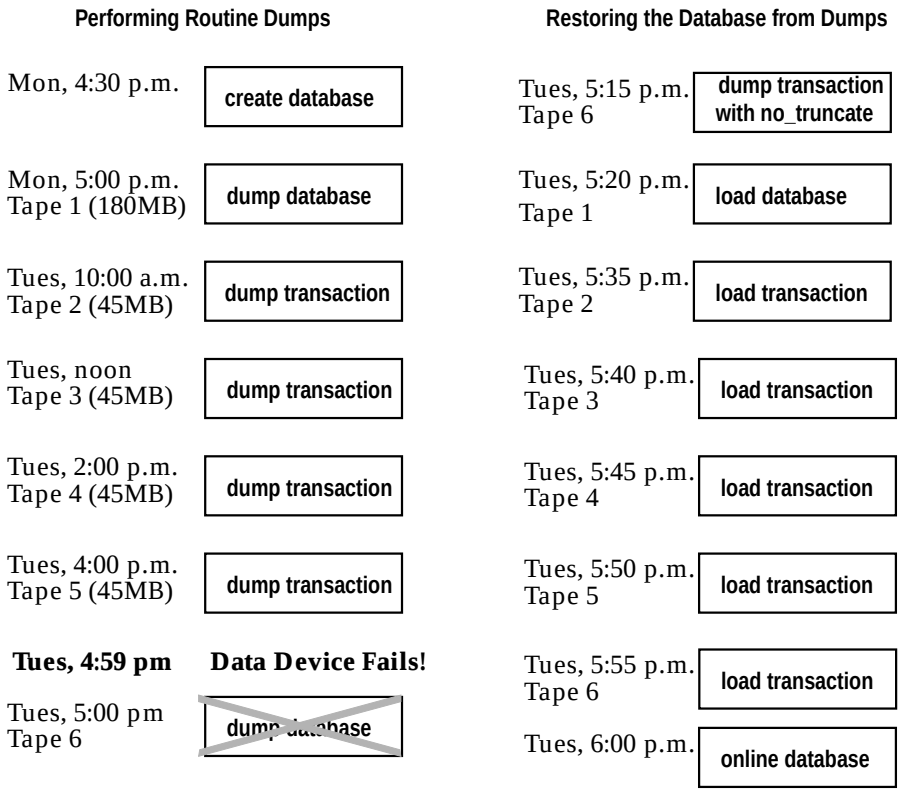


Figure 26-4: Restoring a database, a second scenario

Use the following steps to restore the database:

1. Use **dump transaction with no_truncate** to get a current transaction log dump on Tape 6 (the tape you would have used for the routine database dump).
2. Use **load database** to load the most recent database dump, Tape 1. **load database** sets the database status to "offline."
3. Use **load transaction** to load Tapes 2, 3, 4, and 5 and the most recent transaction log dump, Tape 6.
4. Use **online database** to set the database status to "online."

Designating Responsibility for Backups

Many organizations have an operator who performs all backup and recovery operations. Only a System Administrator, a Database Owner, or an operator can execute the dump and load commands. The Database Owner can dump only his or her own database. The operator and System Administrator can dump and load any database.

Any user can execute **sp_volchanged** to notify the Backup Server when a tape volume is changed. On OpenVMS systems, the operator responsible for changing tape volumes must have permission to execute the **REPLY** command.

Using the Backup Server for Backup and Recovery

Dumps and loads are performed by an Open Server program, Backup Server, running on the same machine as Adaptive Server. You can perform backups over the network, using a Backup Server on a remote computer and another on the local computer.

Backup Server:

- Creates and loads from "striped dumps." **Dump striping** allows you to use up to 32 backup devices in parallel. This splits the database into approximately equal portions and backs up each portion to a separate device.
- Creates and loads single dumps that span several tapes.
- Dumps and loads over the network to a Backup Server running on another machine.
- Dumps several databases or transaction logs onto a single tape.
- Loads a single file from a tape that contains many database or log dumps.
- Supports platform-specific tape handling options.
- Directs volume-handling requests to the session where the dump or load command was issued or to its operator console.
- Detects the physical characteristics of the dump devices to determine protocols, block sizes, and other characteristics.

Relationship Between Adaptive Server and Backup Servers

Figure 26-5 shows two users performing backup activities simultaneously on two databases:

- User1 is dumping database *db1* to a remote Backup Server.
- User2 is loading database *db2* from the local Backup Server.

Each user issues the appropriate dump or load command from a Adaptive Server session. Adaptive Server interprets the command and sends remote procedure calls (RPCs) to the Backup Server. The calls indicate which database pages to dump or load, which dump devices to use, and other options.

While the dumps and loads execute, Adaptive Server and Backup Server use RPCs to exchange instructions and status messages. Backup Server—not Adaptive Server—performs all data transfer for the dump and load commands.

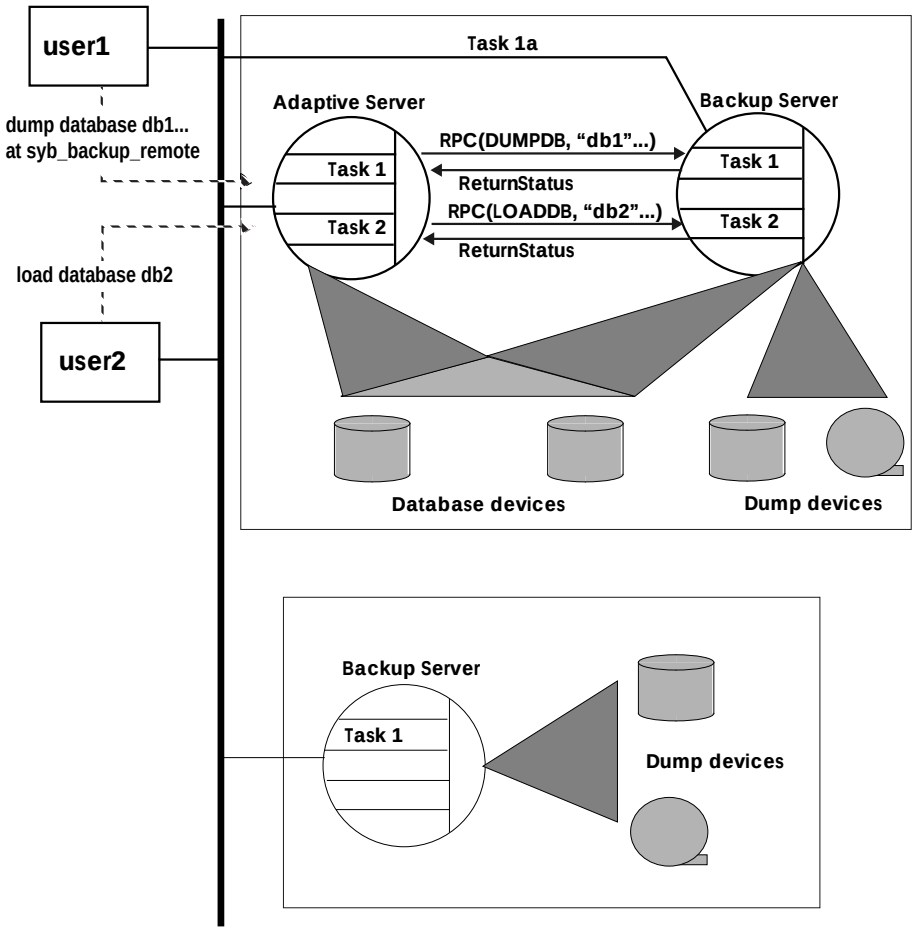


Figure 26-5: Adaptive Server and Backup Server with remote Backup Server

When the local Backup Server receives user1's dump instructions, it reads the specified pages from the database devices and sends them to the remote Backup Server. The remote Backup Server saves the data to offline media.

Simultaneously, the local Backup Server performs user2's load command by reading data from local dump devices and writing it to the database device.

Communicating with the Backup Server

To use the dump and load commands, an Adaptive Server must be able to communicate with its Backup Server. These are the requirements:

- The Backup Server must be running on the same machine as the Adaptive Server (or on the same cluster for OpenVMS).
- The Backup Server must be listed in the *master..sysservers* table. The Backup Server entry, SYB_BACKUP, is created in *sysservers* when you install Adaptive Server. Use **sp_helpserver** to see this information.
- The Backup Server must be listed in the interfaces file. The entry for the local Backup Server is created when you install Adaptive Server. The name of the Backup Server listed in the interfaces file must match the column *srvnet* name for the SYB_BACKUP entry in *master..sysservers*. If you have installed a remote Backup Server on another machine, create the interfaces file on a file system that is shared by both machines, or copy the entry to your local interfaces file. The name of the remote Backup Server must be the same in both interfaces files.
- The user who starts the Backup Server process must have write permission for the dump devices. The "sybase" user, who usually starts Adaptive Server and Backup Server, can read from and write to the database devices.
- Adaptive Server must be configured for remote access. By default, Adaptive Server is installed with remote access enabled. See "Configuring Your Server for Remote Access" on page 26-32 for more information.

Mounting a New Volume

During the backup and restore process, change tape volumes. If the Backup Server detects a problem with the currently mounted volume, it requests a volume change by sending messages to either the client or its operator console. After mounting another volume, the operator notifies the Backup Server by executing **sp_volchanged** on Adaptive Server.

On UNIX systems, the Backup Server requests a volume change when the tape capacity has been reached. The operator mounts another tape and then executes **sp_volchanged** (see Table 26-2).

On OpenVMS systems, the operating system requests a volume change when it detects the end of a volume or when the specified drive is offline. The operator uses the **REPLY** command to reply to these messages.

Table 26-2: Changing tape volumes on a UNIX system

Sequence	Operator Using *isql*	Adaptive Server	Backup Server
1	Issues the **dump database** command		
2		Sends dump request to Backup Server	
3			Receives dump request message from Adaptive Server Sends message for tape mounting to operator Waits for operator's reply
4	Receives volume change request from Backup Server Mounts tapes Executes **sp_volchanged**		
5			Checks tapes If tapes are okay, begins dump When tape is full, sends volume change request to operator
6	Receives volume change request from Backup Server Mounts tapes Executes **sp_volchanged**		
7			Continues dump When dump is complete, sends messages to operator and Adaptive Server

Table 26-2: Changing tape volumes on a UNIX system (continued)

Sequence	Operator Using *isql*	Adaptive Server	Backup Server
8	Receives message that dump is complete	Receives message that dump is complete	
	Removes and labels tapes	Releases locks	
		Completes the **dump database** command	

Starting and Stopping Backup Server

Most UNIX systems use the **startserver** utility to start Backup Server on the same machine as Adaptive Server. On Windows NT, you can start Backup Server from Sybase Central. See the configuration documentation for your platform for information about starting Backup Server.

Use **shutdown** to shut down a Backup Server. See Chapter 4, "Diagnosing System Problems," and the *Adaptive Server Reference Manual* for information about this command.

Configuring Your Server for Remote Access

The **remote access** configuration parameter is set to 1 when you install Adaptive Server. This allows Adaptive Server to execute remote procedure calls to the Backup Server.

For security reasons, you may want to disable remote access except when dumps and loads are taking place. To disable remote access, use:

```
sp_configure "allow remote access", 0
```

Before you perform a dump or load, use the following command to re-enable remote access:

```
sp_configure "allow remote access", 1
```

allow remote access is dynamic and does not require a restart of Adaptive Server to take effect. Only a System Security Officer can set **allow remote access**.

Choosing Backup Media

Tapes are preferred as dump devices, since they permit a library of database and transaction log dumps to be kept offline. Large databases can span multiple tape volumes. On UNIX systems, the Backup Server requires nonrewinding tape devices for all dumps and loads.

For a list of supported dump devices, see the the configuration documentation for your platform.

Protecting Backup Tapes from Being Overwritten

The **tape retention in days** configuration parameter determines how many days' backup tapes are protected from being overwritten. The default value of **tape retention in days** is 0. Which means that backup tapes can be overwritten immediately.

Use **sp_configure** to change the **tape retention in days** value. The new value takes effect the next time you restart Adaptive Server:

```
sp_configure "tape retention in days", 14
```

Both **dump database** and **dump transaction** provide a **retaindays** option that overrides the **tape retention in days** value for that dump.

Dumping to Files or Disks

In general, dumping to a file or disk is not recommended. If the disk or computer containing that file crashes, there may be no way to recover the dumps. On UNIX and PC systems, the entire *master* database dump must fit into a single volume. On these systems, dumping to a file or disk is your only option if the *master* database is too large to fit on a single tape volume, unless you have a second Adaptive Server that can issue **sp_volchanged** requests.

Dumps to a file or disk can be copied to tape for offline storage, but these tapes must be copied back to an online file before they can be read by Adaptive Server. Backup Server cannot directly read a dump that is made to a disk file and then copied to tape.

Creating Logical Device Names for Local Dump Devices

If you are dumping to or loading from local devices (that is, if you are not performing backups over a network to a remote Backup Server),

you can specify dump devices either by providing their physical locations or by specifying their logical device names. In the latter case, you may want to create logical dump device names in the *sysdevices* system table of the *master* database.

➤ ***Note***

If you are dumping to or loading from a remote Backup Server, you must specify the absolute path name of the dump device. You cannot use a logical device name.

The *sysdevices* table stores information about each database and backup device, including its *physical_name* (the actual operating system device or file name) and its *device_name* (or logical name, known only within Adaptive Server). On most platforms, Adaptive Server has one or two aliases for tape devices installed in *sysdevices*. The physical names for these devices are common disk drive names for the platform; the logical names are *tapedump1* and *tapedump2*.

When you create backup scripts and threshold procedures, use logical names, rather than physical device names, and whenever possible, you must modify scripts and procedures that refer to actual device names each time you replace a backup device. If you use logical device names, you can simply drop the *sysdevices* entry for the failed device and create a new entry that associates the logical name with a different physical device.

Listing the Current Device Names

To list the backup devices for your system, run:

```
select * from master..sysdevices
  where status = 16 or status = 24
```

To list both the physical and logical names for database and backup devices, use **sp_helpdevice**:

```
sp_helpdevice tapedump1

device_name physical_name
 description
 status cntrltype device_number low      high
 ------ --------- ------------- -------- -------
tapedump1 /dev/nrmt4

tape, 625 MB, dump device
   16          3             0        0   20000
```

Adding a Backup Device

Use **sp_addumpdevice** to add a backup device:

```
sp_addumpdevice{ "tape" | "disk"} , logicalname,
   physicalname, tapesize
```

physicalname can be either an absolute path name or a relative path name. During dumps and loads, the Backup Server resolves relative path names by looking in Adaptive Server's current working directory.

tapesize is the capacity of the tape in megabytes. OpenVMS systems ignore the *tapesize* parameter if it is specified. Other platforms require this parameter for tape devices but ignore it for disk devices. The Backup Server uses the *tapesize* parameter if the dump command does not specify a tape capacity.

tapesize must be at least 1MB and should be slightly below the capacity rated for the device.

Redefining a Logical Device Name

To use an existing logical device name for a different physical device, drop the device with **sp_dropdevice** and then add it with **sp_addumpdevice**. For example:

```
sp_dropdevice tapedump2
sp_addumpdevice "tape", tapedump2, "/dev/nrmt8", 625
```

Scheduling Backups of User Databases

A major task in developing a backup plan is determining how often to back up your databases. The frequency of your backups determines how much work you will lose in the event of a media failure. This section presents some guidelines about when to dump user databases and transaction logs.

Scheduling Routine Backups

Dump each user database just after you create it, to provide a base point, and on a fixed schedule thereafter. Daily backups of the transaction log and weekly backups of the database are the minimum recommended. Many installations with large and active

databases make database dumps every day and transaction log dumps every half hour or hour.

Interdependent databases—databases where there are cross-database transactions, triggers, or referential integrity—should be backed up at the same time, during a period when there is no cross-database data modification activity. If one of these databases fails and needs to be reloaded, they should all be reloaded from these simultaneous dumps.

◆ ***WARNING!***

Always dump both databases immediately after adding, changing, or removing a cross-database constraint or dropping a table that contains a cross-database constraint.

Other Times to Back Up a Database

In addition to routine dumps, you should dump a database each time you upgrade a user database, create a new index, perform an unlogged operation, or run the **dump transaction with no_log** or **dump transaction with truncate_only** command.

Dumping a User Database After Upgrading

After you upgrade a user database to the current version of Adaptive Server, dump the newly upgraded database to create a dump that is compatible with the current release. A **dump database** must occur on upgraded user databases before a **dump transaction** is permitted.

Dumping a Database After Creating an Index

When you add an index to a table, **create index** is recorded in the transaction log. As it fills the index pages with information, however, Adaptive Server does not log the changes.

If your database device fails after you create an index, **load transaction** may take as long to reconstruct the index as **create index** took to build it. To avoid lengthy delays, dump each database immediately after creating an index on one of its tables.

Dumping a Database After Unlogged Operations

Adaptive Server writes the data for the following commands directly to disk, adding no entries (or, in the case of **bcp**, minimal entries) in the transaction log:

- Non-logged **writetext**
- **select into** on a permanent table
- Fast bulk copy (**bcp**) into a table with no triggers or indexes

You cannot recover any changes made to the database after issuing one of these commands. To ensure that these commands are recoverable, issue a **dump database** command immediately after executing any of these commands.

Dumping a Database When the Log Has Been Truncated

dump transaction with truncate_only and **dump transaction with no_log** remove transactions from the log without making a backup copy. To ensure recoverability, you must dump the database each time you run either command because of lack of disk space. You cannot copying the transaction log until you have done so. See "Using the Special dump transaction Options" on page 26-23 for more information.

If the **trunc log on chkpt** database option is set to **true**, and the transaction log contains 50 rows or more, Adaptive Server truncates the log when an automatic checkpoint occurs. If this happens, you must dump the entire database—not the transaction log—to ensure recoverability.

Scheduling Backups of *master*

Back up the *master* database **regularly and frequently.**

Backups of the *master* database are used as part of the recovery procedure in case of a failure that affects the *master* database. If you do not have a current backup of *master*, you may have to reconstruct vital system tables at a time when you are under pressure to get your databases up and running again.

Dumping *master* After Each Change

Although you can restrict the creation of database objects in *master*, system procedures such as **sp_addlogin** and **sp_droplogin**, **sp_password**,

and **sp_modifylogin** allow users to modify system tables in the database. Back up the *master* database frequently to record these changes.

Back up the *master* database after each command that affects disks, storage, databases, or segments. Always back up *master* after issuing any of the following commands or system procedures:

- **disk init**, **sp_addumpdevice**, or **sp_dropdevice**
- Disk mirroring commands
- The segment system procedures **sp_addsegment, sp_dropsegment**, or **sp_extendsegment**
- **create procedure** or **drop procedure**
- **sp_logdevice**
- **sp_configure**
- **create database** or **alter database**

Saving Scripts and System Tables

For further protection, save the scripts containing all of your **disk init**, **create database**, and **alter database** commands and make a hard copy of your *sysdatabases*, *sysusages*, and *sysdevices* tables each time you issue one of these commands.

You cannot user buildmaster to automatically recover changes that result from these commands. If you keep your scripts—files containing Transact-SQL statements—you can run them to re-create the changes. Otherwise, you must reissue each command against the rebuilt *master* database.

You should also keep a hard copy of *syslogins*. When you recover *master* from a dump, compare the hard copy to your current version of the table to be sure that users retain the same user IDs.

For information on the exact queries to run against the system tables, see “Backing Up master and Keeping Copies of System Tables” on page 2-4.

Truncating the *master* Database Transaction Log

Since the *master* database transaction log is on the same database devices as the data, you cannot back up its transaction log separately. You cannot move the log of the *master* database. You must always use

dump database to back up the master database. Use **dump transaction** with the **truncate_only** option periodically (for instance, after each database dump) to purge the transaction log of the *master* database.

Avoiding Volume Changes and Recovery

When you dump the *master* database, be sure that the entire dump fits on a single volume, unless you have more than one Adaptive Server that can communicate with your Backup Server. You must start Adaptive Server in single-user mode before loading the *master* database. This does not allow a separate user connection to respond to Backup Server's volume change messages during the load. Since *master* is usually small in size, placing its backup on a single tape volume is typically not a problem.

Scheduling Backups of the *model* Database

Keep a current database dump of the *model* database. Each time you make a change to the *model* database, make a new backup. If *model* is damaged and you do not have a backup, you must reenter all the changes you have made to restore *model*.

Truncating the *model* Database's Transaction Log

model, like *master*, stores its transaction log on the same database devices as the data. You must always use **dump database** to back up the *model* database and **dump transaction** with **truncate_only** to purge the transaction log after each database dump.

Scheduling Backups of the *sybsystemprocs* Database

The *sybsystemprocs* database stores only system procedures. Restore this database by running the **installmaster** script, unless you make changes to the database.

If you change permissions on some system procedures, or create your own system procedures in *sybsystemprocs*, your two recovery choices are:

- Run **installmaster**, then reenter all of your changes by re-creating your procedures or by re-executing the **grant** and **revoke** commands.

- Back up *sybsystemprocs* each time you make a change to it.

Both of these recovery options are described in Chapter 28, "Restoring the System Databases."

Like other system databases, *sybsystemprocs* stores its transaction log on the same device as the data. You must always use **dump database** to back up *sybsystemprocs*. By default, the **trunc log on chkpt** option is set to **true** (on) in *sybsystemprocs*, so you should not need to truncate the transaction log. If you change this database option, be sure to truncate the log when you dump the database.

If you are running on a UNIX system or PC, and you have only one Adaptive Server that can communicate with your Backup Server, be sure that the entire dump of *sybsystemprocs* fits on a single dump device. Signaling volume changes requires **sp_volchanged**, and you cannot use this procedure on a server while *sybsystemprocs* is in the process of recovery.

Configuring Adaptive Server for Simultaneous Loads

Adaptive Server can perform multiple load and dump commands simultaneously. Loading a database requires one 16K buffer for each active database load. By default, Adaptive Server is configured for six simultaneous loads. To perform more loads simultaneously, a System Administrator can increase the value of number of large i/o buffers:

```
sp_configure "number of large i/o buffers", 12
```

This parameter requires a restart of Adaptive Server. See "number of large i/o buffers" on page 17-23 for more information. These buffers are not used for **dump** commands or for **load transaction**.

Gathering Backup Statistics

Use **dump database** to make several practice backups of an actual user database and **dump transaction** to back up a transaction log. Recover the database with **load database** and apply successive transaction log dumps with **load transaction**.

Keep statistics on how long each dump and load takes and how much space it requires. The more closely you approximate real-life backup conditions, the more meaningful your predictions will be.

After you have developed and tested your backup procedures, commit them to paper. Determine a reasonable backup schedule and

adhere to it. If you develop, document, and test your backup procedures ahead of time, you will be much better prepared to get your databases online if disaster strikes.

27 Backing Up and Restoring User Databases

Regular and frequent backups are your only protection against database damage that results from failure of your database devices.

This chapter includes these topics:

Dump and Load Command Syntax

The **dump database**, **dump transaction**, **load database**, and **load transaction** commands have parallel syntax. Routine dumps and loads require

the name of a database and at least one dump device. The commands can also include the following options:

- **at** *server_name* to specify the remote Backup Server
- **density**, **blocksize**, and **capacity** to specify tape storage characteristics
- **dumpvolume** to specify the volume name of the ANSI tape label
- **file =** *file_name* to specify the name of the file to dump to or load from
- **stripe on** *stripe_device* to specify additional dump devices
- **dismount**, **unload**, **init**, and **retaindays** to specify tape handling
- **notify** to specify whether Backup Server messages are sent to the **client** that initiated the dump or load or to the **operator_console**

Table 27-1 shows the syntax for routine database and log dumps and for dumping the log after a device failure. It indicates what type of information is provided by each part of the **dump database** or **dump transaction** statement.

Table 27-1: Syntax for routine dumps and log dumps after device failure

Information Provided	Task	
	Routine Database or Log Dump	**Log Dump After Device Failure**
Command	**dump** {**database** | **transaction**}	**dump transaction**
Database name	*database_name*	*database_name*
Dump device	**to** *stripe_device*	**to** *stripe_device*
Remote Backup Server	[**at** *server_name*]	[**at** *server_name*]
Tape device characteristics	[**density =** *density*, **blocksize =** *number_bytes*, **capacity =** *number_kilobytes*]	[**density =** *density*, **blocksize =** *number_bytes*, **capacity =** *number_kilobytes]*
Volume name	[**, dumpvolume =** *volume_name*]	[**, dumpvolume =** *volume_name]*
File name	[**, file** = *file_name*]	[**, file =** *file_name*]
Characteristics of additional devices (up to 31 devices; one set per device)	[**stripe on** *stripe_device*	[**stripe on** *stripe_device*
	[**at** *server_name]*	[**at** *server_name]*
	[**density =** *density*,	[**density =** *density*,
	blocksize = *number_bytes*,	**blocksize =** *number_bytes*,
	capacity = *number_kilobytes*, **file =** *file_name*,	**capacity =** *number_kilobytes*, **file =** *file_name*,
	dumpvolume = *volume_name*]]...	**dumpvolume** = *volume_name*]]...
Options that apply to entire dump	[**with** { **density =** *density*, **blocksize =** *number_bytes*, **capacity =** *number_kilobytes*, **file =** *file_name*, [**nodismount** | **dismount**],	[**with** { **density =** *density*, **blocksize =** *number_bytes*, **capacity =** *number_kilobytes*, **file =** *file_name*, [**nodismount** | **dismount**],
	[**nounload** | **unload**],	[**nounload** | **unload**],
	[**retaindays =** *number_days*],	[**retaindays =** *number_days*],
	[**noinit** | **init**], **file =** *file_name*, **dumpvolume =** *volume_name* **standby_access**	[**noinit** | **init**], **file =** *file_name*, **dumpvolume =** *volume_name*, **standby_access**
Do not truncate log		**no_truncate**
Message destination	[**, notify =** {**client** | **operator_console**}] }]	[**, notify =** {**client** | **operator_console**}] }]

Table 27-2 shows the syntax for loading a database, applying transactions from the log, and returning information about dump headers and files.

Table 27-2: Syntax for load commands

Information Provided	Task	
	Load Database or Apply Recent Transactions	**Return Header or File Information but Do Not Load Backup**
Command	**load** {**database** | **transaction**}	**load** {**database** | **transaction**}
Database name	*database_name*	*database_name*
Dump device	**from** *stripe_device*	**from** *stripe_device*
Remote Backup Server	[**at** *server_name*]	[at *server_name*]
Tape device characteristics	[**density =** *density*,	[**density =** *density*,
Volume name	[, **dumpvolume =** *volume_name*]	[, **dumpvolume =** *volume_name*]
File name	[, **file =** *file_name*]	[, **file =** *file_name*]
Characteristics of additional devices (up to 31 devices; one set per device)	[**stripe on** *stripe_device* [**at** *server_name*] [**density =** *density*, **file =** *file_name*, **dumpvolume =** *volume_name*]]...	[**stripe on** *stripe_device* [**at** *server_name*] [**density =** *density*, **file =** *file_name*, **dumpvolume =** *volume_name*]]...
Tape handling	[**with**{ [**density =** *density*, **dumpvolume =** *volume_name*, **file =** *file_name*, [**nodismount** | **dismount**], [**nounload** | **unload**]	[**with**{ [**density =** *density*, **dumpvolume =** *volume_name*, **file =** *file_name*, [**nodismount** | **dismount**], [**nounload** | **unload**]
Provide header information		[, **headeronly**]
List dump files		[, **listonly** [= **full**]]
Message destination	[, **notify =** {**client** | **operator_console**}]}]	[, **notify =** {**client** | **operator_console**}]}]
Do not load open transactions	**standby_access**	

Table 27-3 shows the syntax for truncating a log:

- That is not on a separate segment
- Without making a backup copy

- With insufficient free space to successfully complete a **dump transaction** or **dump transaction with truncate_only** command

Table 27-3: Special dump transaction options

Information Provided	Task		
	Truncate Log on Same Segment as Data	**Truncate Log Without Making a Copy**	**Truncate Log with Insufficient Free Space**
Command	**dump transaction**	**dump transaction**	**dump transaction**
Database name	*database_name*	*database_name*	*database_name*
Do not copy log	**with truncate_only**	**with truncate_only**	**with no_log**

The remainder of this chapter provides greater detail about the information specified in dump and load commands and volume change messages. Routine dumps and loads are described first, followed by log dumps after device failure and the special syntax for truncating logs without making a backup copy.

For information about the permissions required to execute the dump and load commands, refer to “Designating Responsibility for Backups” on page 26-27.

Specifying the Database and Dump Device

At a minimum, all dump and load commands must include the name of the database being dumped or loaded. Commands that dump or load data (rather than just truncating a transaction log) must also include a dump device.

Table 27-4 shows the syntax for backing up and loading a database or log.

Table 27-4: Indicating the database name and dump device

	Backing Up a Database or Log	Loading a Database or Log
Database name Dump device	**dump** {**database** | **tran**} *database_name* **to** *stripe_device*	**load** {**database** | **tran**} *database_name* **from** *stripe_device*
	[**at** *server_name*] [**density =** *density*, **blocksize =** *number_bytes*, **capacity =** *number_kilobytes*, **dumpvolume =** *volume_name*, **file =** *file_name*] [**stripe on** *stripe_device* [**at** *server_name*] [**density =** *density*, **blocksize =** *number_bytes*, **capacity =** *number_kilobytes*, **dumpvolume =** *volume_name*, **file =** *file_name*] ...] [**with**{ **density =** *density*, **blocksize =** *number_bytes*, **capacity =** *number_kilobytes*, **dumpvolume =** *volume_name*, **file =** *file_name*, [**nodismount** | **dismount**], [**nounload** | **unload**], **retaindays =** *number_days*, [**noinit** | **init**], [**notify =** {**client** | **operator_console**}] **standby_access**}]	[**at** *server_name*] [**density =** *density*, **dumpvolume =** *volume_name* **file =** *file_name*] [**stripe on** *stripe_device* [**at** *server_name*] [**density =** *density*, **dumpvolume =** *volume_name*, **file =** *file_name*] ...] [**with**{ **density =** *density*, **dumpvolume =** *volume_name*, **file =** *file_name*, [**nodismount** | **dismount**], [**nounload** | **unload**], [**notify =** {**client** | **operator_console**}]}]

Rules for Specifying Database Names

You can specify the database name as a literal, a local variable, or a parameter to a stored procedure.

If you are loading a database from a dump:

- The database must exist. You can create a database with the **for load** option of **create database**, or load it over an existing database. Loading a database always overwrites all the information in the existing database.
- You do not need to use the same database name as the name of the database you dumped. For example, you can dump the *pubs2*

database, create another database called *pubs2_archive*, and load the dump into the new database.

◆ ***WARNING!***

You should never change the name of a database that contains primary keys for references from other databases. If you must load a dump from such a database and provide a different name, first drop the references to it from other databases.

Rules for Specifying Dump Devices

When you specify a dump device:

- You can specify the dump device as a literal, a local variable, or a parameter to a stored procedure.
- You cannot dump to or load from the "null device" (on UNIX, */dev/null*; on OpenVMS, any device name beginning with NL; not applicable to PC platforms).
- When dumping to or loading from a local device, you can use any of the following forms to specify the dump device:
  - An absolute path name
  - A relative path name
  - A logical device name from the *sysdevices* system table

  The Backup Server resolves relative path names using Adaptive Server's current working directory.
- When dumping or loading over the network:
  - You must specify the absolute path name of the dump device. You cannot use a relative path name or a logical device name from the *sysdevices* system table.
  - The path name must be valid on the machine on which the Backup Server is running.
  - If the name includes any characters except letters, numbers, or the underscore (_), you must enclose it in quotes.
- If you dump a transaction log using **with standby_access**, you must load the dump using **with standby_access**.

Examples

The following examples use a single tape device for dumps and loads. (It is not necessary to use the same device for dumps and loads.)

On UNIX:

```
dump database pubs2 to "/dev/nrmt4"
load database pubs2 from "/dev/nrmt4"
```

On OpenVMS:

```
dump database pubs2 to "MTA0:"
load database pubs2 from "MTA0:"
```

On Windows NT:

```
dump database pubs2 to "\\.\tape0"
load database pubs2 from "\\.\tape0"
```

You can also dump to an operating system file. The following example is for Windows NT:

```
dump database pubs2 to "d:\backups\backup1.dat"
load database pubs2 from "d:\backupbackup1.dat"
```

Tape Device Determination by Backup Server

When you issue a **dump database** or **dump transaction** command, Backup Server checks whether the device type of the specified dump device is known (supplied and supported internally) by Adaptive Server. If the device is not a known type, Backup Server checks the tape configuration file (default location is *$SYBASE/backup_tape.cfg)* for the device configuration.

If the configuration is found, the **dump** command proceeds.

If the configuration is not found in the tape device configuration file, the **dump** command fails with the following error message:

```
Device not found in configuration file. INIT needs
to be specified to configure the device.
```

To configure the device, issue the **dump database** or **dump transaction** with the **init** parameter. Using operating system calls, Backup Server attempts to determine the device's characteristics; if successful, it stores the device characteristics in the tape configuration file.

If Backup Server cannot determine the dump device characteristics, it defaults to one dump per tape. The device cannot be used if the configuration fails to write at least one dump file.

Tape configuration by Backup Server applies only to UNIX platforms.

Tape Device Configuration File

Format

The tape device configuration file contains tape device information that is used only by the **dump** command.

The format of the file is one tape device entry per line. Fields are separated by blanks or tabs.

Creation

This file is created only when Backup Server is ready to write to it (**dump database** or **dump transaction** with **init**). When Backup Server tries to write to this file for the first time, the following warning message is issued:

```
Warning, unable to open device configuration file
for reading. Operating system error. No such file
or directory.
```

Ignore this message. Backup Server gives this warning and then creates the file and writes the configuration information to it.

Manual Editing

The only user interaction with the file occurs when the user receives the following error message:

```
Device does not match the current configuration.
Please reconfigure this tape device by removing
the configuration file entry and issuing a dump
with the INIT qualifier.
```

This means that the tape hardware configuration changed for a device name. Delete the line entry for that device name and issue a **dump** command, as instructed.

Default Location

The default path name for the configuration file is *$SYBASE/backup_tape.cfg*. You can change the default location with

the Sybase installation utilities. See the installation documentation for your platform for more information.

Specifying a Remote Backup Server

Use the **at** *server_name* clause to send dump and load requests over the network to a Backup Server running on another machine.

Table 27-5 shows the syntax for dumping or loading from a remote Backup Server.

Table 27-5: Dumping to or loading from a remote Backup Server

	Backing Up a Database or Log	Loading a Database or Log
	dump {**database** | **tran**} *database_name* **to** *stripe_device*	**load** {**database** | **tran**} *database_name* **from** *stripe_device*
Remote Backup Server	[**at** *server_name*]	[**at** *server_name*]
	[**density =** *density*, **blocksize =** *number_bytes*, **capacity =** *number_kilobytes*, **dumpvolume =** *volume_name*, **file =** *file_name*] [**stripe on** *stripe_device* [**at** *server_name*] [**density =** *density*, **blocksize =** *number_bytes*, **capacity =** *number_kilobytes*, **dumpvolume =** *volume_name*, **file =** *file_name*] ...] [**with**{ **density =** *density*, **blocksize =** *number_bytes*, **capacity =** *number_kilobytes*, **dumpvolume =** *volume_name*, **file =** *file_name*, [**nodismount** | **dismount**], [**nounload** | **unload**], **retaindays =** *number_days*, [**noinit** | **init**], [**notify =** {**client** | **operator_console**}] **standby_access**}]	[**density =** *density*, **dumpvolume =** *volume_name*, **file =** *file_name*] [**stripe on** *stripe_device* [**at** *server_name*] [**density =** *density*, **dumpvolume =** *volume_name*, **file =** *file_name*] ...] [**with**{ **density =** *density*, **dumpvolume =** *volume_name*, **file =** *file_name*, [**nodismount** | **dismount**], [**nounload** | **unload**], [**notify =** {**client** | **operator_console**}] **standby_access**}]

Sending dump and load requests over the network is ideal for installations that use a single machine with multiple tape devices for

all backups and loads. Operators can be stationed at these machines, ready to service all tape change requests.

The *server_name* must appear in the interfaces file on the computer where Adaptive Server is running, but does not need to appear in the *sysservers* table. The *server_name* must be the same in both the local and the remote interfaces file.

The following examples dump to and load from the remote Backup Server REMOTE_BKP_SERVER:

```
dump database pubs2
        to "/dev/nrmt0" at REMOTE_BKP_SERVER

load database pubs2
        from "/dev/nrmt0" at REMOTE_BKP_SERVER
```

Specifying Tape Density, Block Size, and Capacity

In most cases, the Backup Server uses a default tape density and block size that are optimal for your operating system; **we recommend that you use them**.

You can specify a density, block size, and capacity for each dump device. You can also specify the **density**, **blocksize**, and **capacity** options in the **with** clause for all dump devices. Characteristics that are specified for an individual tape device take precedence over those that you specify using the **with** clause.

Table 27-6 shows the syntax for specifying the tape density, block size, and capacity.

Table 27-6: Specifying tape density, block size, and capacity

	Backing Up a Database or Log	Loading a Database or Log
	dump {**database** | **tran**} *database_name* **to stripe_device** [**at** *server_name*]	**load** {**database** | **tran**} *database_name* **from** *stripe_device* [**at** *server_name*]
Characteristics of a Single Tape Device	[**density =** *density*, **blocksize =** *number_bytes*, **capacity =** *number_kilobytes*,	[**density =** *density*,
	dumpvolume = *volume_name*, **file =** *file_name*] [**stripe on** *stripe_device*] [**at** *server_name*] [**density =** *density*, **blocksize =** *number_bytes*, **capacity =** *number_kilobytes*, **dumpvolume =** *volume_name*, **file =** *file_name*] ...]	**dumpvolume =** *volume_name*, **file =** *file_name*] [**stripe on** *stripe_device*] [**at** *server_name*] [**density =** *density*, **dumpvolume =** *volume_name*, **file =** *file_name*] ...]
Characteristics of All Dump Devices	[**with**{ **density =** *density*, **blocksize =** *number_bytes*, **capacity =** *number_kilobytes*,	[**with**{ **density =** *density*,
	dumpvolume = *volume_name*, **file =** *file_name*, [**nodismount** | **dismount**], [**nounload** | **unload**], **retaindays =** *number_days*, [**noinit** | **init**], [**notify =** {**client** | **operator_console**}] **standby_access**}]	**dumpvolume =** *volume_name*, **file =** *file_name*, [**nodismount** | **dismount**], [**nounload** | **unload**], [**notify =** {**client** | **operator_console**}] **standby_access**}]

The following sections provide greater detail about the **density**, **blocksize**, and **capacity** options.

Overriding the Default Density

The dump and load commands use the default tape density for your operating system. In most cases, this is the optimal density for tape dumps.

When you are dumping to tape on OpenVMS systems, you can override the default density with the **density** = *density* option. Valid densities are **800**, **1600**, **6250**, **6666**, **10000**, and **38000**. Not all densities are valid for all tape drives; specify a value that is correct for your drive.

This option has no effect on OpenVMS tape loads or on UNIX and PC platform dumps or loads.

➤ ***Note***

Specify tape density only when using the **init** tape handling option. For more information on this option, see "Reinitializing a Volume Before a Dump" on page 27-27.

Overriding the Default Block Size

The blocksize parameter specifies the number of bytes per I/O operation for a dump device. By default, the dump and load commands choose the "best" block size for your operating system. Wherever possible, use these defaults.

You can use the **blocksize** = *number_bytes* option to override the default block size for a particular dump device. The block size must be at least one database page (2048 bytes) and must be an exact multiple of the database page size.

For OpenVMS systems, you can specify a block size only for dumps. Use a block size of less than or equal to 55,296.

For UNIX systems, the block size specified on the load command is ignored. Backup Server uses the block size that was used to make the dump.

Specifying a Higher Block Size Value

If you dump to a tape using the **dump database** or **dump transaction** commands, and specify a block size value which is higher than the maximum blocksize of a device as determined by Backup Server, then the dump or the load may fail on certain tape drives. An operating system error message displays; for example, on an 8mm tape drive on HP the error message is:

```
Backup Server: 4.141.2.22: [2] The 'write' call
failed for device 'xxx' with error number 22
(Invalid argument). Refer to your operating system
documentation for further details.
```

You should not specify a block size greater than the device's block size stored in the tape device configuration file in *$SYBASE/backup_tape.cfg*. The block size for a device is the fifth field of the line in the tape device configuration file.

This error occurs only on tape drives where tape auto config is run; that is, the device models are not hard-coded in Backup Server code.

Specifying Tape Capacity for Dump Commands

By default, OpenVMS systems write until they reach the physical end-of-tape marker, and then signal that a volume change is required. For UNIX platforms that cannot reliably detect the end-of-tape marker, you must indicate how many kilobytes can be dumped to a tape.

If you specify the physical path name of the dump device, you must include the **capacity** = *number_kilobytes* parameter in the dump command. If you specify the logical dump device name, the Backup Server uses the *size* parameter stored in the *sysdevices* table, unless you override it with the **capacity** = *number_kilobytes* parameter.

The specified capacity must be at least five database pages (each page requires 2048 bytes). We recommend that you specify a capacity that is slightly below the capacity rated for your device.

A general rule for calculating capacity is to use 70 percent of the manufacturer's maximum capacity for the device, and allow 30 percent for overhead (inter-record gaps, tape marks, and so on). This rule works in most cases, but may not work in all cases because of differences in overhead across vendors and devices.

Non-Rewinding Tape Functionality For Backup Server

The non-rewinding tape functionality automatically positions the tape at the end of valid dump data, which saves time when you want to perform multiple dump operations.

Dump Label Changes

Backup Server writes an End-of-File label, EOF3, at the end of every dump operation.

➤ ***Note***

You cannot load a tape with this label into any version of Adaptive Server earlier then 12.0.

Tape Operations

When a new dump is performed, Backup Server performs a scan for the last EOF3 label.

If the EOF3 label is found, the pertinent information is saved and the tape is positioned forward to the beginning of the next file on tape. This is the new append point.

If the EOF3 label is not found or any other problem is encountered, Backup Server rewinds the tape and scans forward. Any error that occurs during these steps does not abort the dump operation, but causes Backup Server to default to rewind-and-scan behavior. If the error persists during the rewind and scan, the **dump** command aborts.

Dump Version Compatibility

Backup Server activates non-rewinding logic only if the label version on the tape is greater than or equal to 5. Therefore, a **dump** command with the **with init** clause is needed to activate this logic. If a **dump without init** is initiated onto a volume with a label version less than 5, you are prompted to change the volume, and the dump starts on the next volume. The label version of a multi-volume dump does not change in the middle of the volume set.

Table 27-7 defines the label versions for which the new behavior is enabled.

Table 27-7: Label version compatibility

Label Version	Enabled
'3'	No
'4'	No
'5'	Yes
'6'	Yes

Specifying the Volume Name

Use the **with dumpvolume =** *volume_name* option to specify the volume name. **dump database** and **dump transaction** write the volume name to the SQL tape label. **load database** and **load transaction** check the label. If the wrong volume is loaded, Backup Server generates an error message.

You can specify a volume name for each dump device. You can also specify a volume name in the **with** clause for all devices. Volume names specified for individual devices take precedence over those specified in the **with** clause.

Table 27-8 shows the syntax for specifying a volume name.

Table 27-8: Specifying the volume name

	Backing Up a Database or Log	Loading a Database or Log
	dump {**database** | **tran**} *database_name* **to** *stripe_device* [**at** *server_name*] [**density =** *density*, **blocksize =** *number_bytes*, **capacity =** *number_kilobytes*,	**load** {**database** | **tran**} *database_name* **from** *stripe_device* [**at** *server_name*] [**density =** *density*,
Volume name for single device	**dumpvolume =** *volume_name*,	**dumpvolume =** *volume_name*,
	file = *file_name*] [**stripe on** *stripe_device* [**at** *server_name*] [**density =** *density*, **blocksize =** *number_bytes*, **capacity =** *number_kilobytes*, **dumpvolume =** *volume_name*, **file =** *file_name*] ...] [**with**{ **density =** *density*, **blocksize =** *number_bytes*, **capacity =** *number_kilobytes*,	**file =** *file_name*] [**stripe on** *stripe_device* [**at** *server_name*] [**density =** *density*, **dumpvolume =** *volume_name*, **file =** *file_name*]...] [**with** { **density =** *density*,
Volume name for all devices	**dumpvolume =** *volume_name*,	**dumpvolume =** *volume_name*,
	file = *file_name*, [**nodismount** | **dismount**], [**nounload** | **unload**], **retaindays =** *number_days*, [**noinit** | **init**], [**notify =** {**client** | **operator_console**}] **standby_access**}]	**file =** *file_name*, [**nodismount** | **dismount**], [**nounload** | **unload**], [**notify =** {**client** | **operator_console**}] **standby_access**}]

Loading from a Multifile Volume

When you load a database dump from a volume that contains multiple dump files, specify the dump file name. If you omit the dump file name and specify only the database name, Backup Server loads the first dump file into the specified database. For example, entering the following command loads the first dump file from the

tape into *pubs2*, regardless of whether that dump file contains data from *pubs2*:

```
load database pubs2 from "/dev/rdsk/clt3d0s6"
```

To avoid this problem, specify a unique dump file name each time you dump or load data. To get information about the dump files on a given tape, use the **listonly = full** option of **load database**.

Identifying a Dump

When you dump a database or transaction log, Backup Server creates a default file name for the dump by concatenating the:

- Last 7 characters of the database name
- 2-digit year number
- 3-digit day of the year (1–366)
- Number of seconds since midnight, in hexadecimal

You can override this default using the **file =** *file_name* option. The file name cannot exceed 17 characters and must conform to the file naming conventions for your operating system.

You can specify a file name for each dump device. You can also specify a file name for all devices in the **with** clause. File names specified for individual devices take precedence over those specified in the **with** clause.

Table 27-9 shows the syntax for specifying the name of a dump.

Table 27-9: Specifying the file name for a dump

	Backing Up a Database or Log	Loading a Database or Log
	dump {**database** | **tran**} *database_name* **to** *stripe_device* [**at** *server_name*] [**density =** *density*, **blocksize =** *number_bytes*, **capacity =** *number_kilobytes*, **dumpvolume =** *volume_name*,	**load** {**database** | **tran**} *database_name* **from** *stripe_device* [**at** *server_name*] [**density =** *density*, **dumpvolume =** *volume_name*,
File name for single device	**file =** *file_name*]	**file =** *file_name*]

Table 27-9: Specifying the file name for a dump (continued)

	Backing Up a Database or Log	Loading a Database or Log
	[**stripe on** *stripe_device* [**at** *server_name*] [**density =** *density*, **blocksize =** *number_bytes*, **capacity =** *number_kilobytes*, **dumpvolume =** *volume_name*, **file =** *file_name*] ...] [**with**{ **density =** *density*, **blocksize =** *number_bytes*, **capacity =** *number_kilobytes*, **dumpvolume =** *volume_name*,	[**stripe on** *stripe_device*] [**at** *server_name*] [**density =** *density*, **dumpvolume =** *volume_name*, **file =** *file_name*] ...] [**with**{ **density =** *density*, **dumpvolume =** *volume_name*,
File name for all devices	**file =** *file_name*,	**file =** *file_name*,
	[**nodismount** | **dismount**], [**nounload** | **unload**], **retaindays =** *number_days*, [**noinit** | **init**], [**notify =** {**client** | **operator_console**}] **standby_access**}]	[**nodismount** | **dismount**], [**nounload** | **unload**], [**notify =** {**client** | **operator_console**}] **standby_access**}]

The following examples dump the transaction log for the *publications* database without specifying a file name. The default file name, *cations930590E100*, identifies the database and the date and time the dump was made:

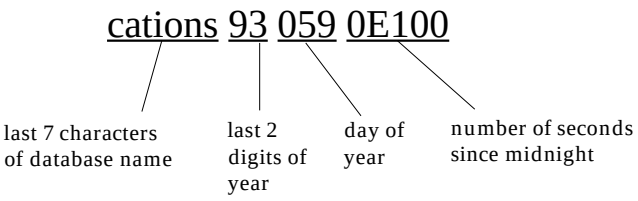


Figure 27-1: File-naming convention for database and transaction log dumps

Backup Server sends the file name to the default message destination or to the **notify** location for the dump command. Be sure to label each backup tape with the volume name and file name before storing it.

When you load a database or transaction log, you can use the **file =** *file_name* clause to specify which dump to load from a volume that contains multiple dumps.

When loading the dump from a multifile volume, you must specify the correct file name.

```
dump tran publications
    to "/dev/nrmt3"
load tran publications
    from "/dev/nrmt4"
    with file = "cations930590E100"
```

The following examples use a user-defined file-naming convention. The 15-character file name, *mydb97jul141800*, identifies the database (*mydb*), the date (July 14, 1997), and the time (18:00, or 6:00 p.m.) that the dump was made. Using the load command advances the tape to *mydb97jul141800* before loading:

```
dump database mydb
    to "/dev/nrmt3"
    with file = "mydb97jul141800"

load database mydb
    from "/dev/nrmt4"
    with file = "mydb97jul141800"
```

Improving Dump or Load Performance

When you start Backup Server, you can use the **-m** parameter to improve the performance of the **dump** and **load** commands by configuring more shared memory for the Backup Server. The **-m** parameter specifies the maximum amount of shared memory used by the Backup Server. You must also configure your operating system to ensure that this amount of shared memory is available to the Backup Server. After a dump or load operation is completed, its shared memory segments are released.

➤ ***Note***

Configuring more shared memory improves dump/load performance only if the performance limits of the hardware setup have not been reached. Increasing the value of **-m** may not result in improved performance when dumping to a slow tape device such as QIC, but it can improve performance significantly when dumping to a faster device such as DLT.

Syntax

The syntax is:

backupserver [-m *nnn*]

where *nnn* is the maximum amount of shared memory in megabytes that the Backup Server can use for all of its dump or load sessions.

Comments

This option sets the upper limit for shared memory usage. However, Backup Server may use less memory than specified if it detects that adding more memory will not improve performance.

Backup Server determines the amount of shared memory available for each stripe by dividing the **-m** value by the configured number of service threads (**-P** parameter).

The default value for **-m** is the number of service threads multiplied by 1MB. The default value for **-P** is 48, so the default maximum shared memory utilization is 48MB. However, Backup Server reaches this usage only if all the 48 service threads are active concurrently.

If you increase the maximum number of service threads, increase the **-m** value, also. If you increase the **-P** value but do not increase the **-m** value, the shared memory allocated per stripe can decrease to the point that the dump or load cannot be processed.

To determine how much to increase the **-m** value, use this formula:

(**-m** value in MB) * 1024 / (**-P** value)

If the value obtained by this formula is less than 128KB, Backup Server will not boot.

The minimum value for **-m** is 6MB. The maximum value for **-m** depends on operating system limits on shared memory.

If you create a dump using a Backup Server with a high shared memory value, and attempt to load the dump using a Backup Server with a lower shared memory value, Backup Server uses only the available memory. This results in degradation of the load performance.

If the amount of shared memory available per stripe at load time is less than twice the block size used at dump time, Backup Server aborts the load with an error message.

Compatibility with Prior Versions

There are some compatibility issues between dump files and Backup Server. Table 27-10 indicates the dump file formats that can be loaded by the current and previous versions of local Backup Servers.

Table 27-10:Server for local operations

	New Dump File Format	Old Dump File Format
New version of server	Yes	Yes
Prior version of server	No	Yes

Table 27-11 and Table 27-12 indicate the dump file formats that can be loaded by the current and prior versions of remote Backup Servers. In a remote Backup Server scenario, the master server is the Backup Server on the same machine as the database and Adaptive Server Enterprise, and the slave server is the Backup Server on the same remote machine as the archive device.

Table 27-11 indicates the **load** operations that work when master server is the current version of Backup Server.

Table 27-11:New version of master server

	New Dump File Format	Old Dump File Format
New slave version of server	Yes	Yes
Prior slave version of server	No	Yes

Table 27-12 indicates the **load** operations that work when the master server is a prior version.

Table 27-12:Prior version of master server

	New Dump File Format	Old Dump File Format
New slave version of server	No	Yes
Prior slave version of server	No	Yes

Specifying Additional Dump Devices: the *stripe on* Clause

Dump striping allows you to use multiple dump devices for a single dump or load command. Use a separate **stripe on** clause to specify the name (and, if desired, the characteristics) of each device.

Each dump or load command can have up to 31 **stripe on** clauses (for a maximum of 32 dump devices).

Table 27-13 shows the syntax for using more than one dump device.

Table 27-13: Using more than one dump device

	Backing Up a Database or Log	Loading a Database or Log
	dump {**database** | **tran**} *database_name* **to** *stripe_device* [**at** *server_name*] [**density =** *density*, **blocksize =** *number_bytes*, **capacity =** *number_kilobytes*, **dumpvolume =** *volume_name*, **file =** *file_name*]	**load** {**database** | **tran**} *database_name* **from** *stripe_device* [**at** *server_name*] [**density =** *density*, **dumpvolume =** *volume_name*, **file =** *file_name*]
Characteristics of an additional tape device (one set per device; up to 31 devices)	[**stripe on** *stripe_device* [**at** *server_name*] [**density =** *density*, **blocksize =** *number_bytes*, **capacity =** *number_kilobytes*, **dumpvolume =** *volume_name*, **file =** *file_name*] ...]	[**stripe on** *stripe_device* [**at** *server_name*] [**density =** *density*, **dumpvolume =** *volume_name*, **file =** *file_name*] ...]
	[**with**{ **density =** *density*, **blocksize =** *number_bytes*, **capacity =** *number_kilobytes*, **dumpvolume =** *volume_name*, **file =** *file_name*, [**nodismount** | **dismount**], [**nounload** | **unload**], **retaindays =** *number_days*, [**noinit** | **init**], [**notify =** {**client** | **operator_console**}] **standby_access**}]	[**with**{ **density =** *density*, **dumpvolume =** *volume_name*, **file =** *file_name*, [**nodismount** | **dismount**], [**nounload** | **unload**], [**notify =** {**client** | **operator_console**}] **standby_access**}]

Dumping to Multiple Devices

The Backup Server divides the database into approximately equal portions and sends each portion to a different device. Dumps are made concurrently on all devices, reducing the time required to dump an individual database or transaction log. Because each tape stores only a portion of the database, it is less likely that a new tape will have to be mounted on a particular device.

◆ ***WARNING!***

Do not dump the *master* database to multiple tape devices. When loading the *master* database from tape or other removable media, you cannot change volumes unless you have another Adaptive Server that can respond to volume change messages.

Loading from Multiple Devices

You can use up to 32 devices to load a database or transaction log. Using multiple devices decreases both the time required for the load and the likelihood of having to mount multiple tapes on a particular device.

Using Fewer Devices to Load Than to Dump

You can load a database or log even if one of your dump devices becomes unavailable between the dump and load. Specify fewer stripe clauses in the load command than you did in the dump command.

➤ ***Note***

When you dump and load over the network, you must use the same number of drives for both operations.

The following examples use three devices to dump a database but only two to load it:

```
dump database pubs2 to "/dev/nrmt0"
    stripe on "/dev/nrmt1"
    stripe on "/dev/nrmt2"

load database pubs2 from "/dev/nrmt0"
    stripe on "/dev/nrmt1"
```

After the first two tapes are loaded, a message notifies the operator to load the third.

You can also dump a database to multiple operating system files. The following example is for Windows NT:

```
dump database pubs2 to "d:\backups\backup1.dat"
    stripe on "d:\backups\backup2.dat"
    stripe on "d:\backups\backup3.dat"
```

```
load database pubs2 from "/dev/nrmt0"
stripe on "d:\backups\backup2.dat"
    stripe on "d:\backups\backup3.dat"
```

Specifying the Characteristics of Individual Devices

Use a separate **at** *server_name* clause for each stripe device attached to a remote Backup Server. If you do not specify a remote Backup Server name, the local Backup Server looks for the dump device on the local machine. If necessary, you can also specify separate tape device characteristics (**density, blocksize, capacity, dumpvolume**, and **file**) for individual stripe devices.

The following examples use three dump devices, each attached to the remote Backup Server REMOTE_BKP_SERVER.

On UNIX:

```
dump database pubs2
        to "/dev/nrmt0" at REMOTE_BKP_SERVER
        stripe on "/dev/nrmt1" at REMOTE_BKP_SERVER
        stripe on "/dev/nrmt2" at REMOTE_BKP_SERVER
```

On OpenVMS:

```
dump database pubs2
    to "MTA0:" at REMOTE_BKP_SERVER
    stripe on "MTA1:" at REMOTE_BKP_SERVER
    stripe on "MTA2:" at REMOTE_BKP_SERVER
```

Tape Handling Options

The tape handling options, which appear in the **with** clause, apply to all devices used for the dump or load. They include:

- **nodismount** to keep the tape available for additional dumps or loads
- **unload** to rewind and unload the tape following the dump or load
- **retaindays** to protect files from being overwritten
- **init** to reinitialize the tape rather than appending the dump files after the last end-of-tape mark

Table 27-14 shows the syntax for tape handling options.

Table 27-14: Tape handling options

	Backing Up a Database or Log	Loading a Database or Log
	dump {**database** | **tran**} *database_name* **to** *stripe_device* [**at** *server_name*] [**density =** *density*, **blocksize =** *number_bytes*, **capacity =** *number_kilobytes*, **dumpvolume =** *volume_name*, **file =** *file_name*] [**stripe on** *stripe_device* [**at** *server_name]* [**density =** *density*, **blocksize =** *number_bytes*, **capacity =** *number_kilobytes*, **dumpvolume =** *volume_name*, **file =** *file_name*] ...] [**with**{ **density =** *density*, **blocksize =** *number_bytes*, **capacity =** *number_kilobytes*, **dumpvolume =** *volume_name*, **file =** *file_name*,	**load** {**database** | **tran**} *database_name* **from** *stripe_device* [**at** *server_name*] [**density =** *density*, **dumpvolume =** *volume_name* **file =** *file_name*] [**stripe on** *stripe_device* [**at** *server_name*] [**density =** *density*, **dumpvolume =** *volume_name*, **file =** *file_name*] ...] [**with**{ **density =** *density*, **dumpvolume =** *volume_name*, **file =** *file_name*,
Tape Handling Options	[**nodismount** | **dismount**], [**nounload** | **unload**], **retaindays =** *number_days*, [**noinit** | **init**],	**nodismount** | **dismount**], [**nounload** | **unload**],
	[**notify =** {**client** | **operator_console**}] **standby_access**}]	[**notify =** {**client** | **operator_console**}] **standby_access**}]

Specifying Whether to Dismount the Tape

On platforms that support logical dismounts, such as OpenVMS, tapes are dismounted when a dump or load completes. Use the **nodismount** option to keep the tape mounted and available for additional dumps or loads. This command has no effect on UNIX or PC systems.

Rewinding the Tape

By default, both dump and load commands use the **nounload** tape handling option.

On UNIX systems, this prevents the tape from rewinding after the dump or load completes. This allows you to dump additional databases or logs to the same volume or to load additional databases or logs from that volume. Use the **unload** option for the last dump on the tape to rewind and unload the tape when the command completes.

On OpenVMS systems, tapes are always rewound after a dump or load completes. Use the **unload** option to unthread the tape and eject it from the drive. (This action is equivalent to the **/UNLOAD** qualifier for the OpenVMS **DISMOUNT** command.)

Protecting Dump Files from Being Overwritten

tape retention in days specifies the number of days that must elapse between the creation of a tape file and the time at which you can overwrite it with another dump. This server-wide variable, which you can is set with **sp_configure**, applies to all dumps requested from a single Adaptive Server.

Use the **retaindays** = ***number_days*** option to override the **tape retention in days** parameter for a single database or transaction log dump. The number of days must be a positive integer, or zero if the tape can be overwritten immediately.

➤ ***Note***

tape retention in days and **retaindays** are meaningful only for disk, 1/4-inch cartridge, and single-file media. On multifile media, Backup Server checks only the expiration date of the first file.

Reinitializing a Volume Before a Dump

By default, each dump is appended to the tape following the last end-of-tape mark. Tape volumes are not reinitialized. This allows you to dump multiple databases to a single volume. (New dumps can be appended only to the last volume of a multivolume dump.)

Use the **init** option to overwrite any existing contents of the tape. If you specify **init**, the Backup Server reinitializes the tape **without** checking for:

- ANSI access restrictions
- Files that have not yet expired

- Non-Sybase data (“foreign” tapes on OpenVMS)

The default, **noinit**, checks for all three conditions and sends a volume change prompt if any are present.

The following example initializes two devices, overwriting the existing contents with the new transaction log dumps:

```
dump transaction pubs2
    to "/dev/nrmt0"
    stripe on "/dev/nrmt1"
    with init
```

You can also use the **init** option to overwrite an existing file, if you are dumping a database to an operating system file. The following example is for Windows NT:

```
dump transaction pubs2
    to "d:\backups\backup1.dat"
    stripe on "d:\backups\backup2.dat"
    with init
```

Dumping Multiple Databases to a Single Volume

To dump multiple databases to the same tape volume:

1. Use the **init** option for the first database. This overwrites any existing dumps and places the first dump at the beginning of the tape.
2. Use the default (**noinit** and **nounload**) option for subsequent databases. This places them one after the other on the tape.
3. Use the **unload** option for the last database on the tape. This rewinds and unloads the tape after you dump the last database.

Figure 27-2 illustrates how use to dump three databases to a single tape volume.

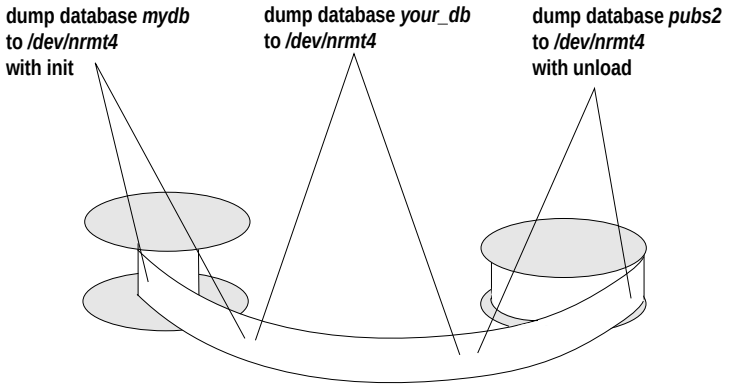


Figure 27-2: Dumping several databases to the same volume

Overriding the Default Message Destination

Backup Server messages inform the operator when to change tape volumes and how the dump or load is progressing. The default destination for these messages depends on whether the operating system offers an operator terminal feature.

The **notify** option, which appears in the **with** clause, allows you to override the default message destination for a dump or load. For this option to work, the controlling terminal or login session from which Backup Server was started must remain active for as long as Backup Server is working; otherwise, the **sp_volchanged** message is lost.

On operating systems that offer an operator terminal feature (such as Open VMS), volume change messages are always sent to an operator terminal on the machine where Backup Server is running. (OpenVMS routes messages to terminals that are enabled for TAPES, DISKS, or CENTRAL.) Use **notify = client** to route other Backup Server messages to the terminal session where the **dump** or **load** request initiated.

On systems such as UNIX that do not offer an operator terminal feature, messages are sent to the client that initiated the dump or load request. Use **notify = operator_console** to route messages to the terminal where the remote Backup Server was started.

Table 27-15 shows the syntax for overriding the default message destination.

Table 27-15: Overriding the default message destination

	Backing Up a Database or Log	Loading a Database or Log
	dump {**database** | **tran**} *database_name* **to** *stripe_device* [**at** *server_name*] [**density =** *density*, **blocksize =** *number_bytes*, **capacity =** *number_kilobytes*, **dumpvolume =** *volume_name*, **file =** *file_name*] [**stripe on** *stripe_device* [**at** *server_name*] [**density =** *density*, **blocksize =** *number_bytes*, **capacity =** *number_kilobytes*, **dumpvolume =** *volume_name*, **file =** *file_name*] ...] [**with**{ **density =** *density*, **blocksize =** *number_bytes*, **capacity =** *number_kilobytes*, **dumpvolume =** *volume_name*, **file =** *file_name*, [**nodismount** | **dismount**], [**nounload** | **unload**], **retaindays =** *number_days*, [**noinit** | **init**],	**load** {**database** | **tran**} *database_name* **from** *stripe_device* [**at** *server_name*] [**density =** *density*, **dumpvolume =** *volume_name* **file =** *file_name*] [**stripe on** *stripe_device* [**at** *server_name*] [**density =** *density*, **dumpvolume =** *volume_name*, **file =** *file_name*] ...] [**with**{ **density =** *density*, **dumpvolume =** *volume_name*, **file =** *file_name*, [**nodismount** | **dismount**], [**nounload** | **unload**],
Message destination	[**notify =** {**client** | **operator_console**}]	[**notify =** {**client** | **operator_console**}]
	standby_access}]	**standby_access**}]

Bringing Databases Online *with standby_access*

with standby_access causes **dump transaction** to dump only completed transactions. It dumps the transaction log up to the point at which there are no active transactions. If you do not use **with standby_access**, the entire transaction log, including records for all open transactions is dumped. A transaction log dump using **with standby_access** is illustrated in Figure 27-3.

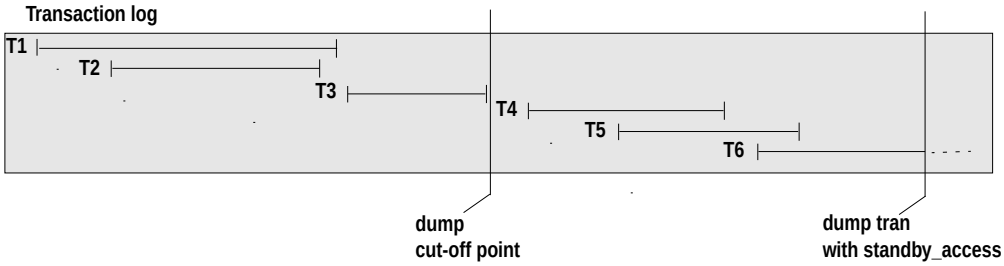


Figure 27-3: Dump cut-off point for dump transaction with standby_access

In Figure 27-3, a **dump transaction...with standby_access** command is issued at a point where transactions T1 through T5 have completed and transaction T6 is still open. The dump cannot include T5 because T6 is still open, and it cannot include T4, because T5 is still open. Thus, the dump must stop at the end of transaction T3, where it will include completed transactions T1 through T3.

The syntax for **with standby_access** is:

```
dump tran[saction] database_name to...
   [with standby_access]
```

For more information about the with **dump tran...with standby_access** option, see the *Adaptive Server Reference Manual*.

When Do I Use *with standby_access*?

Use **dump tran[saction]...with standby_access when** you will be loading two or more transaction logs in sequence, and you want the database to be online between loads. For example, if you have a read-only database that gets its data by loading transaction dumps from a primary database. In this case, if the read-only database is used for generating a daily report based on transactions in the primary database, and the primary database's transaction log is dumped at the end of day, the daily cycle of operations is:

1. On the primary database: **dump tran[saction]...with standby_access**
2. On the read-only database: **load tran[saction]...**
3. On the read-only database: **online database for standby_access**

◆ ***WARNING!***

If a transaction log contains open transactions, and you dump it without using with standby_access, Adaptive Server will not allow you to load the log, bring the database online, and then load a subsequent transaction dump. If you are going to load a series of transaction dumps, you can bring the database online only after loading a dump originally made with standby_access or after loading the entire series.

Bring Databases Online *with standby_access*

The **online database** command also includes a **with standby_access** option. Use **for standby_access** to bring a database online after loading it with a dump that was made using the **with standby_access** option.

◆ ***WARNING!***

If you try to use online database for standby_access with a transaction log that was not dumped using the with standby_access option, the command will fail.

Syntax

The syntax for **online database** is:

```
online database database_name [for standby_access]
```

For more information about the with **online database...for standby_access** option, see the *Adaptive Server Reference Manual*.

Getting Information About Dump Files

If you are unsure of the contents of a tape, use the **with headeronly** or **with listonly** option of the load commands to request that information.

Table 27-16 shows the syntax for finding the contents of a tape.

Table 27-16: Listing dump headers or file names

	Listing Information About a Dump
	load {**database** | **tran**} *database_name* **from** *stripe_device* [**at** *server_name*] [**density =** *density*, **dumpvolume =** *volume_name* **file =** *file_name*] [**stripe on** *stripe_device* [**at** *server_name*] [**density =** *density*, **dumpvolume =** *volume_name*, **file =** *file_name*] ...] [**with**{ **density =** *density*, **dumpvolume =** *volume_name*, **file =** *file_name*, [**nodismount** | **dismount**], [**nounload** | **unload**],
List header information List files on tape	[**headeronly** [, **file =** *filename*]], [**listonly** [**= full**]],
	[**notify =** {**client** | **operator_console**}] **standby_access**}]

➤ ***Note***

Neither **with headeronly** nor **with listonly** loads the dump files after displaying the report.

Requesting Dump Header Information

with headeronly returns the header information for a single file. If you do not specify a file name, **with headeronly** returns information about the first file on the tape.

The header indicates whether the dump is for a database or transaction log, the database ID, the file name, and the date the dump was made. For database dumps, it also shows the character set, sort order, page count, and next object ID. For transaction log dumps, it shows the checkpoint location in the log, the location of the oldest **begin transaction** record, and the old and new sequence dates.

The following example returns header information for the first file on the tape and then for the file *mydb9229510945*:

```
load database mydb
    from "/dev/nrmt4"
    with headeronly

load database mydb
    from "/dev/nrmt4"
    with headeronly, file = "mydb9229510945"
```

Here is sample output from **headeronly**:

```
Backup Server session id is: 44. Use this value when executing
the 'sp_volchanged' system stored procedure after fulfilling any
volume change request from the Backup Server.

Backup Server: 4.28.1.1: Dumpfile name 'mydb9232610BC8 ' section
number 0001 mounted on device 'backup/SQL_SERVER/mydb.db.dump'

This is a database dump of database ID 5 from Nov 21 1992 7:02PM.

Database contains 1536 pages; checkpoint RID=(Rid pageid =
0x404; row num = 0xa); next object ID=3031; sort order ID=50,
status=0; charset ID=1.
```

Determining the Database, Device, File Name, and Date

with listonly returns a brief description of each dump file on a volume. It includes the name of the database, the device used to make the dump, the file name, the date and time the dump was made, and the date and time it can be overwritten. **with listonly = full** provides greater detail. Both reports are sorted by SQL tape label.

Following is sample output of a **load database** command **with listonly**:

```
Backup Server: 4.36.1.1: Device '/dev/nrst0':
File name: 'model9320715138  '
Create date & time: Monday, Jul 26, 1993, 23:58:48
Expiration date & time:  Monday, Jul 26, 1993, 00:00:00
Database name: 'model                          '
```

and sample output from **with listonly = full**:

```
Backup Server: 4.37.1.1: Device '/dev/nrst0':
Label id: 'HDR1'
File name:'model9320715138  '
Stripe count:0001
Device typecount:01
```

```
Archive volume number:0001
Stripe position:0000
Generation number:0001
Generation version:00
Create date & time:Monday, Jul 26, 1993, 23:58:48
Expiration date & time:Monday, Jul 26, 1993, 00:00:00
Access code:‘ ‘
File block count:000000
Sybase id string:
‘Sybase  ‘Reserved:‘       ‘
```

```
Backup Server: 4.38.1.1: Device ‘/dev/nrst0’:
Label id:‘HDR2’
Record format:‘F’
Max. bytes/block:55296
Record length:02048
Backup format version:01
Reserved:‘   ‘
Database name:‘model                          ‘
Buffer offset length:00
Reserved:‘                               ‘
```

After listing all files on a volume, the Backup Server sends a volume change request:

```
Backup Server: 6.30.1.2: Device /dev/nrst0: Volume cataloguing
complete.
Backup Server: 6.51.1.1: OPERATOR: Mount the next volume to
search.
Backup Server: 6.78.1.1: EXECUTE sp_volchanged
          @session_id = 5,
          @devname = ‘/dev/nrst0’,
          @action = { ‘PROCEED’ | ‘RETRY’ | ‘ABORT’ },
          @fname = ‘
```

The operator can use **sp_volchanged** to mount another volume and signal the volume change or to terminate the search operation for all stripe devices.

Copying the Log After a Device Failure

Normally, **dump transaction** truncates the inactive portion of the log after copying it. Use **with no_truncate** to copy the log without truncating it.

no_truncate allows you to copy the transaction log after failure of the device that holds your data. It uses pointers in the *sysdatabases* and *sysindexes* tables to determine the physical location of the transaction

log. It can be used only if your transaction log is on a separate segment and your *master* database is accessible.

◆ ***WARNING!***

Use no_truncate only if media failure makes your data segment inaccessible. Never use no_truncate on a database that is in use.

Copying the log **with no_truncate** is the first step described in "Recovering a Database: Step-by-Step Instructions" on page 27-45.

Table 27-17 shows the syntax for copying a log after a device failure.

Table 27-17: Copying the log file after a device failure

	Copying with the *no_truncate* Option
	dump transaction *database_name* **to** *stripe_device* [**at** *server_name*] [**density =** *density*, **blocksize =** *number_bytes*, **capacity =** *number_kilobytes*, **dumpvolume =** *volume_name*, **file =** *file_name*] [**stripe on** *stripe_device* [**at** *server_name*] [**density =** *density*, **blocksize =** *number_bytes*, **capacity** = *number_kilobytes*, **dump volume =** *volume_name*, **file =** *file_name*] ...] [**with**{ **density =** *density*, **blocksize =** *number_bytes*, **capacity =** *number_kilobytes*, **dumpvolume =** *volume_name*, **file =** *file_name*, [**nodismount** | **dismount**], [**nounload** | **unload**], **retaindays =** *number_days*, [**noinit** | **init**],
Do not truncate log	**no_truncate**,
	[**notify =** {**client** | **operator_console**}] **standby_access**}]

You can use **no_truncate** with striped dumps, tape initialization, and remote Backup Servers. Here is an example:

```
dump transaction mydb
to "/dev/nrmt0" at REMOTE_BKP_SERVER
with init, no_truncate,
notify = "operator_console"
```

Truncating a Log That Is Not on a Separate Segment

If a database does not have a log segment on a separate device from data segments, you cannot use **dump transaction** to copy the log and then truncate it. For these databases, you must:

1. Use the special **with truncate_only** option of **dump transaction** to truncate the log so that it does not run out of space
2. Use **dump database** to copy the entire database, including the log

Because it doesn't copy any data, **with truncate_only** requires only the name of the database:

```
dump transaction database_name with truncate_only
```

The following example dumps the database *mydb*, which does not have a log segment on a separate device from data segments, and then truncates the log:

```
dump database mydb to mydevice
dump transaction mydb with truncate_only
```

Truncating the Log in Early Development Environments

In early development environments, the transaction log is quickly filled by creating, dropping, and re-creating stored procedures and triggers and checking integrity constraints. Recovery of data may be less important than ensuring that there is adequate space on database devices.

with truncate_only allows you to truncate the transaction log without making a backup copy:

```
dump transaction database_name with truncate_only
```

After you run **dump transaction with truncate_only,** you must dump the database before you can run a routine log dump.

Truncating a Log That Has No Free Space

When the transaction log is very full, you may not be able to use your usual method to dump it. If you used **dump transaction** or **dump**

transaction with truncate_only, and the command failed because of insufficient log space, use the special with **no_log option** of **dump transaction**:

```
dump transaction database_name with no_log
```

This option truncates the log without logging the dump transaction event. Because it doesn't copy any data, it requires only the name of the database.

◆ ***WARNING!***

Use dump transaction with no_log as a last resort, and use it only once after dump transaction with truncate_only fails. If you continue to load data after entering dump transaction with no_log, you may fill the log completely, causing any further dump transaction commands to fail. Use alter database to allocate additional space to the database.

All occurrences of **dump tran with no_log** are reported in the Adaptive Server error log. The message includes the user ID of the user executing the command. Messages indicating success or failure are also sent to the error log. **no_log** is the only dump option that generates error log messages.

Dangers of Using *with truncate_only* and *with no_log*

with truncate_only and **with no_log** allow you to truncate a log that has become disastrously short of free space. Neither option provides a means to recover transactions that have committed since the last routine dump.

◆ ***WARNING!***

Run dump database at the earliest opportunity to ensure that your data can be recovered.

The following example truncates the transaction log for *mydb* and then dumps the database:

```
dump transaction mydb
    with no_log
dump database mydb to ...
```

Providing Enough Log Space

Every use of **dump transaction...with no_log** is considered an error and is recorded in the server's error log. If you have created your databases with log segments on a separate device from data segments, written a last-chance threshold procedure that dumps your transaction log often enough, and allocated enough space to your log and database, you should not have to use this option.

However, some situations can still cause the transaction log to become too full, even with frequent log dumps. The **dump transaction** command truncates the log by removing all pages from the beginning of the log, up to the page preceding the page that contains an uncommitted transaction record (known as the oldest active transaction). The longer this active transaction remains uncommitted, the less space is available in the transaction log, since **dump transaction** cannot truncate additional pages.

This can happen when applications with very long transactions modify tables in a database with a small transaction log, which indicates you should increase the size of the log. It also occurs when transactions inadvertently remain uncommitted for long periods of time, such as when an implicit **begin transaction** uses the chained transaction mode or when a user forgets to complete the transaction. You can determine the oldest active transaction in each database by querying the *syslogshold* system table.

The *syslogshold* Table

The *syslogshold* table is in the *master* database. Each row in the table represents either:

- The oldest active transaction in a database, or
- The Replication Server truncation point for the database's log.

A database may have no rows in *syslogshold*, a row representing one of the above, or two rows representing both of the above. For information about how a Replication Sever truncation point affects the truncation of the database's transaction log, see the Replication Server documentation.

Querying *syslogshold* provides a "snapshot" of the current situation in each database. Since most transactions last for only a short time, the query's results may not be consistent. For example, the oldest active transaction described in the first row of *syslogshold* may finish before Adaptive Server completes the query of *syslogshold*. However, when several queries of *syslogshold* over time query the same row for

a database, that transaction may prevent a **dump transaction** from truncating any log space.

When the transaction log reaches the last-chance threshold, and **dump transaction** cannot free up space in the log, you can query *syslogshold* and *sysindexes* to identify the transaction holding up the truncation. For example:

```
select H.spid, H.name
from master..syslogshold H, threshdb..sysindexes I
where H.dbid = db_id("threshdb")
and I.id = 8
and H.page = I.first

spid    name
------  ------------------------------------
     8  $user_transaction

(1 row affected)
```

This query uses the object ID associated with *syslogs* (8) in the *threshdb* database to match the first page of its transaction log with the first page of the oldest active transaction in *syslogshold*.

You can also query *syslogshold* and *sysprocesses* in the *master* database to identify the specific host and application owning the oldest active transactions. For example:

```
select P.hostname, P.hostprocess, P.program_name,
   H.name, H.starttime
from sysprocesses P, syslogshold H
where P.spid = H.spid
and H.spid != 0

hostname hostprocess program_name name              starttime
-------- ----------- ------------ ----------------- -----------------
eagle          15826 isql         $user_transaction  Sep  6 1997 4:29PM
hawk           15859 isql         $user_transaction  Sep  6 1997 5:00PM
condor         15866 isql         $user_transaction  Sep  6 1997 5:08PM

(3 rows affected)
```

Using the above information, you can notify or kill the user process owning the oldest active transaction and proceed with the **dump transaction**. You can also include the above types of queries in the threshold procedures for the database as an automatic alert mechanism. For example, you may decide that the transaction log should never reach its last-chance threshold. If it does, your last-chance threshold procedure (**sp_thresholdaction)** alerts you with information about the oldest active transaction preventing the transaction dump.

➤ ***Note***

The initial log records for a transaction may reside in a user log cache, which is not visible in *syslogshold* until the records are flushed to the log (for example, after a checkpoint).

For more information about the *syslogshold* system table, see the *Adaptive Server Reference Manual*. For information about the last-chance threshold and threshold procedures, see Chapter 29, "Managing Free Space with Thresholds."

Responding to Volume Change Requests

On UNIX and PC systems, use **sp_volchanged** to notify the Backup Server when the correct volumes have been mounted. On OpenVMS systems, use the **REPLY** command.

To use **sp_volchanged**, log in to any Adaptive Server that can communicate with both the Backup Server that issued the volume change request and the Adaptive Server that initiated the dump or load.

sp_volchanged Syntax

Use this syntax for **sp_volchanged**:

```
sp_volchanged session_id, devname , action
   [ ,fname [, vname] ]
```

- Use the *session_id* and *devname* parameters specified in the volume change request.
- *action* specifies whether to **abort**, **proceed** with, or **retry** the dump or load.
- *fname* specifies the file to load. If you do not specify a file name, Backup Server loads the **file** = *file_name* parameter of the load command. If neither **sp_volchanged** nor the load command specifies which file to load, the Backup Server loads the first file on the tape.
- The Backup Server writes the *vname* in the ANSI tape label when overwriting an existing dump, dumping to a brand new tape, or dumping to a tape whose contents are not recognizable. During loads, the Backup Server uses the *vname* to confirm that the correct tape has been mounted. If you do not specify a *vname*, the

Backup Server uses the volume name specified in the dump or load command. If neither **sp_volchanged** nor the command specifies a volume name, the Backup Server does not check this field in the ANSI tape label.

Volume Change Prompts for Dumps

This section describes the volume change prompts that appear while you are dumping a database or transaction log. Each prompt includes the possible operator actions and the appropriate **sp_volchanged** response.

- `Mount the next volume to search.`

  When appending a dump to an existing volume, the Backup Server issues this message if it cannot find the end-of-file mark.

The operator can	By replying
Abort the dump	**sp_volchanged** *session_id*, *devname*, **abort**
Mount a new volume and proceed with the dump	**sp_volchanged** *session_id*, *devname*, **proceed** [, *fname* [, *vname*]]

- `Mount the next volume to write.`

  The Backup Server issues this message when it reaches the end of the tape. This occurs when it detects the end-of-tape mark, dumps the number of kilobytes specified by the **capacity** parameter of the **dump** command, or dumps the *high* value specified for the device in the *sysdevices* system table.

The operator can	By replying
Abort the dump	**sp_volchanged** *session_id*, *devname*, **abort**
Mount the next volume and proceed with the dump	**sp_volchanged** *session_id*, *devname*, **proceed** [, *fname* [, *vname*]]

- `Volume on device devname has restricted access (code access_code).`

  Dumps that specify the **init** option overwrite any existing contents of the tape. Backup Server issues this message if you try

to dump to a tape with ANSI access restrictions without specifying the **init** option.

The operator can	By replying
Abort the dump	**sp_volchanged** *session_id*, *devname*, **abort**
Mount another volume and retry the dump	**sp_volchanged** *session_id*, *devname*, **retry** [, *fname* [, *vname*]]
Proceed with the dump, overwriting any existing contents	**sp_volchanged** *session_id*, *devname*, **proceed** [, *fname* [, *vname*]]

- `Volume on device devname is expired and will be overwritten.`

  Dumps that specify the **init** option overwrite any existing contents of the tape. During dumps to single-file media, Backup Server issues this message if you have not specified the **init** option and the tape contains a dump whose expiration date has passed.

The operator can	By replying
Abort the dump	**sp_volchanged** *session_id*, *devname*, **abort**
Mount another volume and retry the dump	**sp_volchanged** *session_id*, *session_id*, **retry** [, *session_id* [, *session_id*]]
Proceed with the dump, overwriting any existing contents	**sp_volchanged** *session_id*, *session_id*, **proceed** [, *session_id* [, *session_id*]]

- `Volume to be overwritten on 'devname' has not expired: creation date on this volume is creation_date, expiration date is expiration_date.`

  On single-file media, the Backup Server checks the expiration date of any existing dump unless you specify the **init** option. The Backup Server issues this message if the dump has not yet expired.

The operator can	By replying
Abort the dump	**sp_volchanged** *session_id*, *session_id*, **abort**

The operator can	By replying
Mount another volume and retry the dump	**sp_volchanged** *session_id*, *session_id*, **retry** [, *session_id* [, *session_id*]]
Proceed with the dump, overwriting any existing contents	**sp_volchanged** *session_id*, *session_id*, **proceed** [, *session_id* [, *session_id*]]

- `Volume to be overwritten on 'devname' has unrecognized label data.`

  Dumps that specify the **init** option overwrite any existing contents of the tape. Backup Server issues this message if you try to dump to a new tape or a tape with non-Sybase data without specifying the **init** option.

The operator can	By replying
Abort the dump	**sp_volchanged** *session_id*, *session_id*, **abort**
Mount another volume and retry the dump	**sp_volchanged** *session_id*, *session_id*, **retry** [, *session_id* [, *session_id*]]
Proceed with the dump, overwriting any existing contents	**sp_volchanged** *session_id*, *session_id*, **proceed** [, *session_id* [, *session_id*]]

Volume Change Prompts for Loads

Following are the volume change prompts and possible operator actions during loads:

- `Dumpfile 'fname' section vname found instead of 'fname' section vname.`

  The Backup Server issues this message if it cannot find the specified file on a single-file medium.

The operator can	By replying
Abort the load	**sp_volchanged** *session_id*, *session_id*, **abort**
Mount another volume and try to load it	**sp_volchanged** *session_id*, *session_id*, **retry** [, *session_id* [, *session_id*]]

The operator can	By replying
Load the file on the currently mounted volume, even though it is not the specified file (not recommended)	**sp_volchanged** *session_id*, *session_id*, **proceed** [, *session_id* [, *session_id*]]

- `Mount the next volume to read.`

  The Backup Server issues this message when it is ready to read the next section of the dump file from a multivolume dump.

The operator can	By replying
Abort the load	**sp_volchanged** *session_id*, *session_id*, **abort**
Mount the next volume and proceed with the load	**sp_volchanged** *session_id*, *session_id*, **proceed** [, *session_id* [, *session_id*]]

- `Mount the next volume to search.`

  The Backup Server issues this message if it cannot find the specified file on multifile medium.

The operator can	By replying
Abort the load	**sp_volchanged** *session_id*, *session_id*, **abort**
Mount another volume and proceed with the load	**sp_volchanged** *session_id*, *session_id*, **proceed** [, *session_id* [, *session_id*]]

Recovering a Database: Step-by-Step Instructions

The symptoms of media failure are as variable as the causes. If only a single block on the disk is bad, your database may appear to function perfectly for some time after the corruption occurs, unless you are running **dbcc** commands frequently. If an entire disk or disk controller is bad, you will not be able to use a database. Adaptive Server marks the database as suspect and displays a warning message. If the disk storing the *master* database fails, users will not be able to log in to the server, and users already logged in will not be able to perform any actions that access the system tables in *master*.

This section describes what to do when a database device fails. The recommended procedure consists of the following steps:

1. Get a current log dump of **every database on the device**.
2. Examine the space usage of **every database on the device**.
3. After you have gathered this information for all databases on the device, drop each database.
4. Drop the failed device.
5. Initialize new devices.
6. Re-create the databases, one at a time.
7. Load the most recent database dump into each database.
8. Apply each transaction log dump in the order in which it was created.

These steps are described in detail in the following sections.

Getting a Current Dump of the Transaction Log

Use **dump transaction with no_truncate** to get a current transaction log dump **for each database on the failed device**. For example, to get a current transaction log dump of *mydb*:

```
dump transaction mydb
to "/dev/nrmt0" at REMOTE_BKP_SERVER
with init, no_truncate,
notify = "operator_console"
```

Examining the Space Usage

The following steps are recommended to determine which devices your database uses, how much space is allocated on each device, and whether the space is used for data, log, or both. You can use this information when re-creating your databases to ensure that the log, data, and indexes reside on separate devices, and to preserve the scope of any user segments you have created.

➤ ***Note***

You can also use these steps to preserve segment mappings when moving a database dump from one server to another (on the same hardware and software platform).

If you do not use this information to re-create the device allocations for damaged databases, Adaptive Server will **remap** the *sysusages* table after **load database** to account for discrepancies. This means that the database's system-defined and user-defined segments no longer match the appropriate device allocations. Incorrect information in *sysusages* can result in the log being stored on the same devices as the data, even if the data and the log were separate before recovery. It can also change user-defined segments in unpredictable ways, and can result in a database that cannot be created using a standard **create database** command.

To examine and record the device allocations for all damaged databases:

1. In *master*, examine the device allocations and uses for the damaged database:

   ```
   select segmap, size from sysusages
       where dbid = db_id("database_name")
   ```

2. Examine the output of the query. Each row with a *segmap* of "3" represents a data allocation; each row with a *segmap* of "4" represents a log allocation. Higher values indicate user-defined segments; treat these as data allocations, to preserve the scope of these segments. The *size* column indicates the number of 2K blocks of data. To find the number of megabytes, divide by 512. Note the order, use, and size of each disk piece.

   For example, this output:

   ```
   segmap        size
   -------       --------
        3          10240
        3           5120
        4           5120
        8           1024
        4           2048
   ```

   translates into the sizes and uses described in Table 27-18.

Table 27-18: Sample device allocation

Device Allocation	Megabytes
Data	20
Data	10
Log	10
Data (user-defined segment)	2
Log	4

➤ ***Note***

If the *segmap* column contains 7s, your data and log are on the same device, and you can recover only up to the point of the most recent database dump. **Do not** use the **log on** option to **create database**. Just be sure that you allocate as much (or more) space than the total reported from *sysusages*.

3. Run **sp_helpdb *database_name*** for the database. This query lists the devices on which the data and logs are located:

```
name       db_size owner   dbid    created
-------    ------- ------  ----    -----------
mydb       46.0 MB sa        15    Apr  9 1991

status          device_fragments    size          usage
--------------  ----------------    -----         ------------
no options set  datadev1            20 MB         data only
                datadev2            10 MB         data only
                datadev3             2 MB         data only
                logdev1             10 MB         log only
                logdev1              4 MB         log only
```

Dropping the Databases

After you have performed the preceding steps **for all databases on the failed device**, use **drop database** to drop each database.

➤ ***Note***

If tables in other databases contain references to any tables in the database you are trying to drop, you must remove the referential integrity constraints with **alter table** before you can drop the database.

If the system reports errors because the database is damaged when you issue **drop database**, use the **dropdb** option of the **dbcc dbrepair** command:

```
dbcc dbrepair (mydb, dropdb)
```

See the *Troubleshooting Guide* for more information about **dbcc dbrepair**.

Dropping the Failed Devices

After you have dropped each database, use **sp_dropdevice** to drop the failed device. See the *Adaptive Server Reference Manual* for more information.

Initializing New Devices

Use **disk init** to initialize the new database devices. See Chapter 12, "Initializing Database Devices," for more information.

Re-Creating the Databases

Use the following steps to re-create each database using the segment information you collected earlier.

➤ ***Note***

If you chose not to gather information about segment usage, use **create database...for load** to create a new database that is at least as large as the original.

1. Use **create database** with the **for load** option. Duplicate all device fragment mappings and sizes for each row of your database from the *sysusages* table, **up to and including the first log device**. Use the order of the rows as they appear in *sysusages*. (The results of **sp_helpdb** are in alphabetical order by device name, not in order of allocation.) For example, to re-create the *mydb* database allocations shown in Table 27-18 on page 27-47, enter:

```
create database mydb
    on datadev1 = 20,
       datadev2 = 10
log on logdev1 = 10
for load
```

➤ ***Note***

create database...for load temporarily locks users out of the newly created database, and **load database** marks the database offline for general use. This prevents users from performing logged transactions during recovery.

2. Use **alter database** with the **for load** option to re-create the remaining entries, in order. Remember to treat device allocations for user segments as you would data allocations.

   In this example, to allocate more data space on *datadev3* and more log space on *logdev1*, the command is:

```
alter database mydb
     on datadev3 = 2
log on logdev1=4
for load
```

Loading the Database

Reload the database using **load database**. If the original database stored objects on user-defined segments (*sysusages* reports a *segmap* greater than 7) and your new device allocations match those of the dumped database, Adaptive Server preserves the user segment mappings.

If you did not create the new device allocations to match those of the dumped database, Adaptive Server will remap segments to the available device allocations. This remapping may also mix log and data on the same physical device.

➤ ***Note***

If an additional failure occurs while a database is being loaded, Adaptive Server does not recover the partially loaded database, and notifies the user. You must restart the database load by repeating the **load** command.

Loading the Transaction Logs

Use **load transaction** to apply transaction log backups **in the same sequence in which they were made**.

Adaptive Server checks the timestamps on each dumped database and transaction log. If the dumps are loaded in the wrong order, or if user transactions have modified the transaction log between loads, the load fails.

If you dumped the transaction log using **with standby_access**, you must also load the database using **standby_access**.

After you have brought a database up to date, use **dbcc** commands to check its consistency.

Loading a Transaction Log to a Point in Time

You can recover a database up to a specified point in time in its transaction log. To do so, use the **until_time** option of **load transaction**. This is useful if, for example, a user inadvertently drops an important table; you can use **until_time** to recover the changes made to the database containing the table up to a time just before the table was dropped.

To use **until_time** effectively after data has been destroyed, you must know the exact time the error occurred. You can find this by issuing a **select getdate** at the time of the error. For example, suppose a user accidentally drops an important table, and then a few minutes later you get the current time in milliseconds:

```
select convert(char(26), getdate(), 109)

--------------------------
Mar 26 1997 12:45:59:650PM
```

After dumping the transaction log containing the error and loading the most recent database dump, load the transaction logs that were created after the database was last dumped. Then, load the transaction log containing the error by using **until_time**; for example:

```
load transaction employees_db
from "/dev/nrmt5"
with until_time = "Mar 26 1997 12:35:59: 650PM"
```

After you load a transaction log using **until_time**, Adaptive Server restarts the database's log sequence. This means that until you dump the database again, you cannot load subsequent transaction logs after the **load transaction** using **until_time**. You will need to dump the database before you can dump another transaction log.

Bringing the Databases Online

In this example, the transaction log is loaded up to a time just before the table drop occurred. After you have applied all transaction log dumps to a database, use **online database** to make it available for use. In this example, the command to bring the *mydb* database online is:

```
online database mydb
```

Replicated Databases

Before you upgrade replicated databases to the current version of Adaptive Server, the databases must be online. However, you cannot

bring replicated databases online until the logs are drained. If you try to bring a replicated database online before the logs are drained, Adaptive Server issues the following message:

```
Database is replicated, but the log is not yet
drained. This database will come online
automatically after the log is drained.
```

When Replication Server, via the Log Transfer Manager (LTM), drains the log, **online database** is automatically issued.

Upgrading to The Current Release of Adaptive Server

Refer to the installation documentation for your platform for upgrade instructions for Adaptive Server users that have replicated databases.

Load Sequence

The load sequence for loading replicated databases is: **load database**, **replicate**, **load transaction**, **replicate**, and so on. At the end of the load sequence, issue **online database** to bring the databases online. Databases that are offline because they are in a load sequence are not automatically brought online by Replication Server.

◆ ***WARNING!***

Do not issue online database until all transaction logs are loaded.

Loading Database Dumps from Older Versions

When you upgrade an Adaptive Server installation is upgraded to a new release, all databases associated with that server are automatically upgraded.

As a result, database and transaction log dumps created with a previous version of Adaptive Server must be upgraded before they can be used with the current version of Adaptive Server.

Adaptive Server provides an automatic upgrade mechanism – on a per-database basis – for upgrading a database or transaction log made with Backup Sever to the current Adaptive Server release, thus making the dump compatible for use. This mechanism is entirely internal to Adaptive Server, and requires no external programs. It provides the flexibility of upgrading individual dumps as needed.

The following tasks are not supported by this automatic upgrade functionality:

- Loading an older release of the *master* database. That is, if you upgraded Adaptive Server to the current version, you cannot load a dump of the master database from which you upgraded.
- Installing new or modified stored procedures. Continue to use **installmaster.**
- Loading and upgrading dumps generated previous to SQL Server release 10.0.

How to Upgrade a Dump to Adaptive Server

To upgrade a user database or transaction log dump to the current release of Adaptive Server:

1. Use **load database** and **load transaction** to load the dump to be upgraded.

   Adaptive Server determines from the dump header which version it is loading. After the dump header is read, and before Backup Server begins the load, the database is marked offline by **load database** or **load transaction**. This makes the database unavailable for general use (queries and **use** *database* are not permitted), provides the user greater control over load sequences, and eliminates the possibility that other users will accidentally interrupt a load sequence.

2. Use **online database**, after the dump has successfully loaded, to activate the upgrade process.

➤ ***Note***

Do **not** issue **online database** until after all transaction dumps are loaded.

Prior to SQL Server version 11.0, a database was automatically available at the end of a successful load sequence. With the current version of Adaptive Server, the user is required to bring the database online after a successful load sequence, using **online database**.

For dumps loaded from SQL Server version 10.0, **online database** activates the upgrade process to upgrade the dumps just loaded. After the upgrade is successfully completed, Adaptive Server places the database online and the database is ready for use.

For dumps loaded from the current version of Adaptive Server, no upgrade process is activated. You must still issue **online database** to place the database online – **load database** marks it as offline.)

Each upgrade step produces a message stating what it is about to do.

An upgrade failure leaves the database offline and produces a message stating that the upgrade failed and the user must correct the failure.

For more information about **online database**, see the *Adaptive Server Reference Manual*.

3. After successful execution of **online database**, use **dump database**. The database must be dumped before a **dump transaction** is permitted. A **dump transaction** on a newly created or upgraded database is not permitted until a successful **dump database** has occurred.

The "Database Offline" Status Bit

The "database offline" status bit indicates that the database is not available for general use. You can determine whether a database is offline by using **sp_helpdb**. It will show that the database is offline if this bit is set.

When a database is marked offline by **load database**, a status bit in the *sysdatabases* table is set and remains set until the successful completion of **online database**.

The "database offline" status bit works in combination with any existing status bits. It augments the following status bit to provide additional control:

- In recovery

The "database offline" status bit overrides the following status bits:

- DBO use only
- Read only

The following status bits override the "database offline" status bit:

- Began upgrade
- Bypass recovery
- In load
- Not recovered

- Suspect
- Use not recovered

Although the database is not available for general use, you can user these commands when the database is offline:

- **dump database** and **dump transaction**
- **load database** and **load transaction**
- **alter database on device**
- **drop database**
- **online database**
- **dbcc** diagnostics (subject to **dbcc** restrictions)

Version Identifiers

The automatic upgrade feature provides version identifiers for Adaptive Server, databases, and log record formats:

- Configuration upgrade version ID – shows the current version of Adaptive Server; it is stored in the *sysconfigures* table. **sp_configure** displays the current version of Adaptive Server as "upgrade version."
- Upgrade version indicator – shows the current version of a database and is stored in the database and dump headers. The Adaptive Server recovery mechanism uses this value to determine whether the database should be upgraded before being made available for general use.
- Log compatibility version specifier – differentiates version 10.x logs from release 11.x logs by showing the format of log records in a database, database dump, or transaction log dump. This constant is stored in the database and dump headers and is used by Adaptive Server to detect the format of log records during recovery.

Cache Bindings and Loading Databases

If you dump a database and load it onto a server with different cache bindings, you should be aware of cache bindings for a database and the objects in the database. You may want to load the database onto a different server for tuning or development work, or you may need

to load a database that you dropped from a server whose cache bindings have changed since you made the dump.

When you bring a database online after recovery or by using **online database** after a load, Adaptive Server verifies all cache bindings for the database and database objects. If a cache does not exist, Adaptive Server writes a warning to the error log, and the binding in *sysattributes* is marked as invalid. Here is an example of the message from the error log:

```
Cache binding for database '5', object
'208003772', index '3' is being marked invalid in
Sysattributes.
```

Invalid cache bindings are not deleted. If you create a cache of the same name and restart Adaptive Server, the binding is marked as valid and the cache is used. If you do not create a cache with the same name, you can bind the object to another cache or allow it to use the default cache.

In the following sections, which discuss cache binding topics, **destination server** refers to the server where the database is being loaded, and **original server** refers to the server where the dump was made.

If possible, re-create caches that have the same names on the destination server as the bindings on the original server. You may want to configure pools in exactly the same manner if you are using the destination database for similar purposes or for performance testing and development that may be ported back to the original server. If you are using the destination database for decision support or for running **dbcc** commands, you may want to configure pools to allow more space in 16K memory pools.

Databases and Cache Bindings

Binding information for databases is stored in *master..sysattributes*. No information about database binding is stored in the database itself. If you use **load database** to load the dump over an existing database that is bound to a cache, and you do not drop the database before you issue the load command, this does not affect the binding.

If the database that you are loading was bound to a cache on the original server, you can:

- Bind the database on the destination server to a cache configured for the needs on that server, or

- Configure pools in the default data cache on the destination server for the needs of the application there, and do not bind the database to a named data cache.

Database Objects and Cache Bindings

Binding information for objects is stored in the *sysattributes* table in the database itself. If you frequently load the database onto the destination server, the simplest solution is to configure caches of the same name on the destination server.

If the destination server is not configured with caches of the same name as the original server, bind the objects to the appropriate caches on the destination server after you bring the database online, or be sure that the default cache is configured for your needs on that server.

Checking on Cache Bindings

Use sp_helpcache to display the cache bindings for database objects, even if the cache bindings are invalid.

The following SQL statements reproduce cache binding commands from the information in a user database's *sysattributes* table:

```
/* create a bindcache statement for tables */

select "sp_bindcache "+ char_value + ", "
    + db_name() + ", " + object_name(object)
from sysattributes
where class = 3
    and object_type = "T"

/* create a bindcache statement for indexes */

select "sp_bindcache "+ char_value + ", "
    + db_name() + ", "   + i.name
from sysattributes, sysindexes i
where class = 3
    and object_type = "I"
    and i.indid = convert(tinyint, object_info1)
    and i.id = object
```

Cross-Database Constraints and Loading Databases

If you use the **references** constraint of **create table** or **alter table** to reference tables across databases, you may encounter problems when you try to load a dump of one of these databases.

- If tables in a database reference a dumped database, referential integrity errors result if you load the database with a different name or on a different server from where it was dumped. To change the name or location of a database when you reload it, use **alter table** in the referencing database to drop all external referential integrity restraints before you dump the database.
- Loading a dump of a referenced database that is earlier than the referencing database could cause consistency issues or data corruption. As a precaution, each time you add or remove a cross-database constraint or drop a table that contains a cross-database constraint, dump both affected databases.
- Dump all databases that reference each other at the same time. To guard against synchronization problems, put both databases in single-user mode for the dumps. When loading the databases, bring both databases online at the same time.

Cross-database constraints can become inconsistent if you:

- Do not load database dumps in chronological order (for example, you load a dump created on August 12, 1997, after one created on August 13), or
- Load a dump into a database with a new name.

If you do not load, cross-database constraints can become inconsistent.

To remedy this problem:

1. Put both databases in single-user mode.
2. Drop the inconsistent referential constraint.
3. Check the data consistency with a query such as:

   ```
   select foreign_key_col from table
   where foreign_key not in
   (select primary_key_col from other db..othertable)
   ```

4. Fix any data inconsistency problems.
5. Re-create the constraint.

28 Restoring the System Databases

This chapter explains how to restore the *master*, *model* and *sybsystemprocs* databases. Topics include:

What Does Recovering a System Database Entail?

The recovery procedure for system databases depends on the database involved and the problems that you have on your system. In general, recovery may include:

- Using **load database** to load backups of these databases,
- Using **buildmaster**, **installmaster**, and **installmodel** to restore the initial state of these databases, or
- A combination of the above tasks.

To make the recovery of system databases as efficient as possible:

- Do not store user databases or any databases other than *master*, *tempdb*, and *model* on the master device.
- Always keep up-to-date printouts of important system tables.
- Always back up the *master* database after performing actions such as initializing database devices, creating or altering databases, or adding new server logins.

Symptoms of a Damaged *master* Database

A damaged *master* database can be caused by a media failure in the area on which *master* is stored or by internal corruption in the database. You'll know if your *master* database is damaged if:

- Adaptive Server cannot start.

- There are frequent or debilitating segmentation faults or input/output errors.
- **dbcc** reports damage during a regular check of your databases.

Recovering the *master* Database

This section describes how to recover the *master* database and to rebuild the master device. It assumes:

- The *master* database is corrupt, or the master device is damaged.
- You have up-to-date printouts of the system tables, listed in "Backing Up master and Keeping Copies of System Tables" on page 2-4.
- The master device contains **only** the *master* database, *tempdb*, and *model*.
- You have an up-to-date backup of the *master* database, and you have not initialized any devices or created or altered any databases since last dumping *master*.
- Your server uses the default sort order.

You can also use these procedures to move your *master* database to a larger master device.

The *Troubleshooting Guide* provides more complete coverage of recovery scenarios.

About the Recovery Process

Special procedures are needed because of the central, controlling nature of the *master* database and the master device. Tables in *master* configure and control all Adaptive Server's functions, databases, and data devices. The recovery process:

- Rebuilds the master device to its default state when you first installed a server
- Restores the *master* database to the default state
- Restores the *master* database to its condition at the time of your last backup

During the early stages of recovering the *master* database, you cannot use the system stored procedures.

Summary of Recovery Procedure

You must follow the steps below to restore a damaged master device. **Each step is discussed in more detail on the following pages.**

Step	See
Find hard copies of the system tables needed to restore disks, databases and logins.	"Step One: Find Copies of System Tables" on page 28-4
Shut down Adaptive Server, and use **buildmaster** to build a new *master* database and master device.	"Step Two: Build a New Master Device" on page 28-4
Restart Adaptive Server in master-recover mode.	"Step Three: Start Adaptive Server in Master-Recover Mode" on page 28-5
Re-create the *master* database's allocations in *sysusages* exactly**.**	"Step Four: Re-Create Device Allocations for master" on page 28-6
Update Backup Server's network name in the *sysservers* table.	"Step Five: Check Your Backup Server sysservers Information" on page 28-11
Verify that your Backup Server is running.	"Step Six: Verify That Your Backup Server Is Running" on page 28-11
Use **load database** to load the most recent database dump of *master*. Adaptive Server stops automatically after successfully loading *master*.	"Step Seven: Load a Backup of master" on page 28-12
Update the **number of devices** configuration parameter in the configuration file.	"Step Eight: Update the number of devices Configuration Parameter" on page 28-12.
Restart Adaptive Server in single-user mode.	"Step Nine: Restart Adaptive Server in Master-Recover Mode" on page 28-13
Verify that the backup of *master* has the latest system tables information.	"Step Ten: Check System Tables to Verify Current Backup of master" on page 28-13
Restart Adaptive Server.	"Step Eleven: Restart Adaptive Server" on page 28-13
Check *syslogins* if you have added new logins since the last backup of *master*.	"Step Twelve: Restore Server User IDs" on page 28-14
Restore the *model* database.	"Step Thirteen: Restore the model Database" on page 28-14

Step	See
Compare hard copies of *sysusages* and *sysdatabases* with the new online version, run **dbcc checkalloc** on each database, and examine the important tables in each database.	"Step Fourteen: Check Adaptive Server" on page 28-15
Dump the *master* database.	"Step Fifteen: Back Up master" on page 28-15

Step One: Find Copies of System Tables

Find copies of the system tables that you have saved to a file: *sysdatabases*, *sysdevices*, *sysusages*, *sysloginroles*, and *syslogins*. You can use these to guarantee that your system has been fully restored at the completion of this process.

For information on preparing for disaster recovery by making copies of the system tables to a file, see "Backing Up master and Keeping Copies of System Tables" on page 2-4.

Step Two: Build a New Master Device

Before you run **buildmaster**, check your most recent copy of *sysusages*. If it has only one line for *dbid* 1, your *master* database has only one disk allocation piece, and you can go to "Step Five: Check Your Backup Server sysservers Information" on page 28-11.

Shut down Adaptive Server, if it is running, and rebuild the master device. When rebuilding the master device, you must specify the device size.

Before you begin, it is important that you remember to:

- Use a new device, preserving the old device in case you encounter problems. The old device may provide crucial information.
- Shut down Adaptive Server before you use any **buildmaster** command. If you use **buildmaster** on a master device that is in use by Adaptive Server, the recovery procedure will fail when you attempt to load the most recent backup of *master*.

Run **buildmaster** (UNIX), **bldmastr** (Windows NT), or **buildmaster** (OpenVMS) to build a new master device and to install a copy of a "generic" *master* database. Give the full name and full size for your master device.

➤ ***Note***

You must give **buildmaster** a size as large as or larger than the size originally used to configure Adaptive Server. If the size is too small, you will get error messages when you try to load your databases.

The following example rebuilds a 17MB (8704 2K pages) master device.

On UNIX platforms:

```
buildmaster -d /dev/rsd1f -s8704
```

On Windows NT:

```
bldmastr -d d:\devices\master.dat -s8704
```

On OpenVMS:

```
buildmaster
/disk=dua0:[devices.master]d_master.dat/size=8704
```

After you run **buildmaster**, the password for the default "sa" account reverts to NULL.

For details on the **buildmaster** utility, see the *Utility Programs* manual for your platform.

Step Three: Start Adaptive Server in Master-Recover Mode

Start Adaptive Server in master-recover mode with the **-m** (UNIX and Windows NT) or **/masterrecover** (OpenVMS) option.

On UNIX platforms, make a copy of the runserver file, naming it *m_RUN_server_name*. Edit the new file, adding the parameter **-m** to the **dataserver** command line. Then start the server in master-recover mode:

```
startserver -f m_RUN_server_name
```

On OpenVMS, use:

```
startserver /server = server_name /masterrecover
```

On Windows NT, start Adaptive Server from the command line using the **sqlsrver** command. Specify the **-m** parameter in addition to other necessary parameters. For example:

```
sqlsrver.exe -dD:\Sybase\DATA\MASTER.dat -sPIANO -
eD:\Sybase\install\errorlog -iD:\Sybase\ini -MD:\Sybase -m
```

See the *Utility Programs* manual for your platform for the complete syntax of these commands.

When you start Adaptive Server in master-recover mode, only one login of one user—the System Administrator—is allowed. Immediately following a **buildmaster** command on the *master* database, only the "sa" account exists, and its password is NULL.

◆ ***WARNING!***

Some sites have automatic jobs that log in to the server at start-up with the "sa" login. Be sure these are disabled.

Master-recover mode is necessary because the generic *master* database created with **buildmaster** does not match the actual situation in Adaptive Server. For example, the database does not know about any of your database devices. Any operations on the *master* database could make recovery impossible or at least much more complicated and time-consuming.

An Adaptive Server started in master-recover mode is automatically configured to allow direct updates to the system tables. Certain other operations (for example, the checkpoint process) are disallowed.

◆ ***WARNING!***

Ad hoc changes to system tables are dangerous—some changes can render Adaptive Server unable to run. Make only the changes described in this chapter, and always make the changes in a user-defined transaction.

Step Four: Re-Create Device Allocations for *master*

If more than one row for *dbid* 1 appears in your hard copy of *sysusages*, you need to increase the size of *master* so that you can load the dump. You must duplicate the *vstart* value for each allocation for *master* in *sysusages*. This is easiest to do if you have a copy of *sysusages* ordered by *vstart*.

In the simplest cases, additional allocations to *master* require only the use of **alter database.** In more complicated situations, you must allocate space for other databases to reconstruct the exact *vstart* values needed to recover *master*.

In addition to the *master* database, *tempdb* (*dbid* = 2) and *model* (*dbid* = 3) are located wholly or partially on the master device.

Determining Which Allocations Are on the Master Device

To determine which *vstart* values represent allocations on the master device, look at the *sysdevices* table. It shows the low and high values for each device. Databases devices always have a *cntrltype* of 0; the following example does not include the rows for tape devices.

```
low      high     status cntrltype name     phyname  mirrorname
---      ----     ------ --------- ------   -------- ----------
  0      8703     3              0 master   d_master NULL
16777216 16782335 2              0 sprocdev /sybase/ NULL
                                            sp_dev
```

page range for master device

Figure 28-1: Determining allocations on the master device

In this example, page numbers on the master device are between 0 and 8703, so any database allocation with *sysusages.vstart* values in this range represent allocations on the master device.

Check all rows for *master* (except the first) in your saved *sysusages* output. Here is sample *sysusages* information, ordered by *vstart*:

```
dbid segmap lstart size   vstart     pad  unreservedpgs
---- ------ ------ ------ ---------- ---- -------------
   1      7      0   1536          4 NULL           480
   3      7      0   1024       1540 NULL           680
   2      7      0   1024       2564 NULL           680
   1      7   1536   1024       3588 NULL          1024
   4      7      0   5120       4432 NULL          1560
```

dbid = 1, an additional allocation for master

size of this allocation

vstart between 0 and 8703

Figure 28-2: Sample output from sysusages

In this example, the first four rows have *vstart* values between 4 and 3588. Only *dbid* 4 is on another device.

buildmaster re-creates the first three rows, so *sysusages* in your newly rebuilt *master* database should match your hard copy.

The fourth row shows an additional allocation for *master* with *vstart* = 3588 and *size* = 1024.

Figure 28-3 shows the storage allocations for the above *sysusages* data.

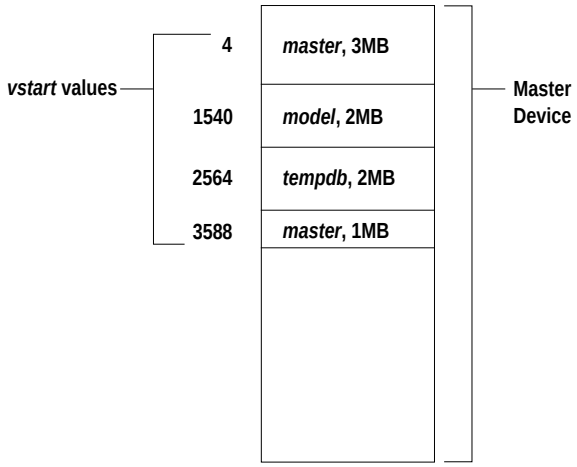


Figure 28-3: Allocations on a master device

In Figure 28-3, you need only to issue an **alter database** command to increase the size of the *master* database. To determine the size to provide for this command, look at the *size* column for the second allocation to *master.* Divide by 512. In this example, the additional row for *master* indicates an allocation of 1024 data pages, so the correct parameter is 2, the result of 1024 / 512.

Use that result for the **alter database** command. Log in to the server as "sa." Remember that **buildmaster** has set the password for this account to NULL. Issue the **alter database** command. For the example above, use:

```
alter database master on master = 2
```

Check the *size* and *vstart* values for the new row in *sysusages*.

Creating Additional Allocations

Your output from *sysusages* may have more allocations on the master device if:

- You have upgraded Adaptive Server from an earlier version
- A System Administrator has increased the size of *master*, *model*, or *tempdb* on the master device

You must restore these allocations up to the last row for the *master* database, *dbid* 1. Here is an example of *sysusages* showing additional allocations on the master device, in *vstart* order:

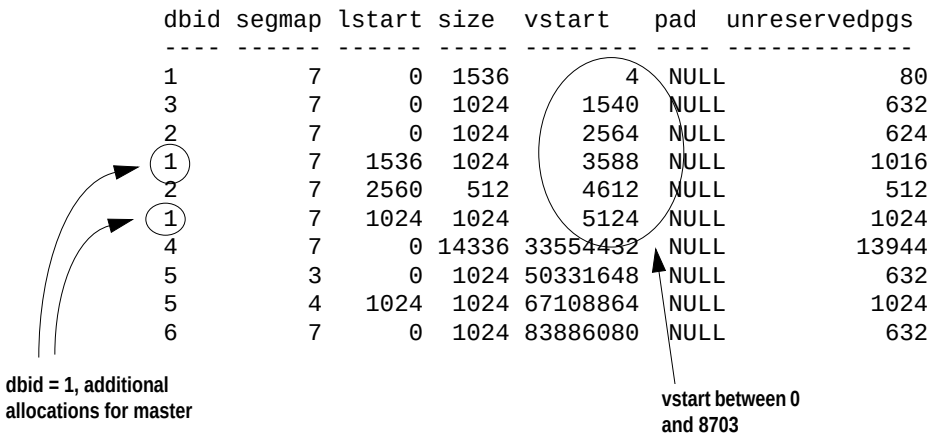


Figure 28-4: Sample sysusages output with additional allocations

This copy of *sysusages* shows the following allocations on the master device (excluding the three created by **buildmaster**):

- One for *master*, *dbid* = 1, *size* = 1024, *vstart* = 3588
- One for *tempdb*, *dbid* = 2, *size* = 512, *vstart* = 4612
- Another allocation for *master*, *dbid* = 1, *size* = 1024, *vstart* = 5124

The final allocations in this output are not on the master device.

Figure 28-5 shows the allocations on the master device.

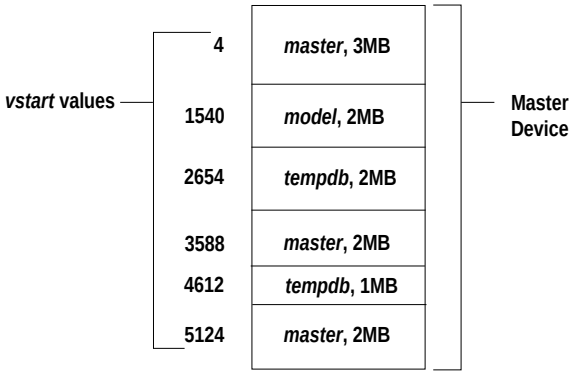


Figure 28-5: Complex allocations on a master device

You need to issue a set of **alter database** and **create database** commands to re-create all the allocations with the correct sizes and *vstart* values. If *sysusages* lists additional allocations on the master device after the last allocation for master, you do not have to re-create them.

To determine the size for the **create database** and **alter database** commands, divide the value shown in the *size* column of the *sysusages* output by 512.

To reconstruct the allocation, issue these commands, in this order:

- To restore the first allocation to *master, dbid* 1, *size* = 1024:

  ```
  alter database master on default = 2
  ```

- To allocate more space to *tempdb, dbid* 2, *size* = 512:

  ```
  alter database tempdb on default = 1
  ```

- To add the final allocation to *master, dbid* 1, *size* = 1024:

  ```
  alter database master on default = 1
  ```

You need to restore only the allocations up to and including the last line for the *master* database. When you load the backup of *master,* this table is completely restored from the dump.

At this point, carefully check the current *sysusages* values with the values in your hard copy:

- If all of the *vstart* and *size* values for *master* match, go to “Step Five: Check Your Backup Server sysservers Information” on page 28-11.

- If the values do not match, an attempt to load the *master* database will almost certainly fail. Shut down the server, and begin again by running **buildmaster**. See "Step Two: Build a New Master Device" on page 28-4.
- If your *sysusages* values look correct, go to "Step Five: Check Your Backup Server sysservers Information" on page 28-11.

Step Five: Check Your Backup Server *sysservers* Information

Log in to the server as "sa," using a null password.

If the network name of your Backup Server is not SYB_BACKUP, you must update *sysservers* so that Adaptive Server can communicate with its Backup Server. Check the Backup Server name in your interfaces file, and issue this command:

```
select *
from sysservers
where srvname = "SYB_BACKUP"
```

Check the *srvnetname* in the output from this command. If it matches the interfaces file entry for the Backup Server for your server, go to "Step Six: Verify That Your Backup Server Is Running" on page 28-11.

If the reported *srvnetname* is **not** the same as the Backup Server in the interfaces file, you must update *sysservers*. The example below changes the Backup Server's network name to PRODUCTION_BSRV:

```
begin transaction

update sysservers
set srvnetname = "PRODUCTION_BSRV"
where srvname = "SYB_BACKUP"
```

Execute this command, and check to be sure that it modified only one row. Issue the **select** command again, and verify that the correct row was modified and that it contains the correct value. If **update** modified more than one row, or if it modified the wrong row, issue a **rollback transaction** command, and attempt the update again.

If the command correctly modified the Backup Server's row, issue a **commit transaction** command.

Step Six: Verify That Your Backup Server Is Running

On UNIX and OpenVMS platforms, use the **showserver** command to verify that your Backup Server is running; restart your Backup

Server if necessary. See **showserver** and **startserver** in the *Utility Programs* manual for your platform.

On Windows NT, a locally installed Sybase Central and the Services Manager show whether Backup Server is running.

See the *Utility Programs* manual for your platform for the commands to start Backup Server.

Step Seven: Load a Backup of *master*

Load the most recent backup of the *master* database. Here are examples of the load commands:

On UNIX platforms:

```
load database master from "/dev/nrmt4"
```

On OpenVMS:

```
load database master from "MTA0:"
```

On Windows NT:

```
load database master from "\\.\TAPE0"
```

See Chapter 27, "Backing Up and Restoring User Databases," for information on command syntax.

After **load database** completes successfully, Adaptive Server shuts down. Watch for any error messages during the load and shut down processes.

Step Eight: Update the *number of devices* Configuration Parameter

Perform this step only if you use more than the default number of database devices. Otherwise, go to "Step Nine: Restart Adaptive Server in Master-Recover Mode" on page 28-13.

Configuration values are not available to Adaptive Server until after recovery of the *master* database, so you need to instruct Adaptive Server to read the appropriate value for the **number of devices** parameter from a configuration file at start-up.

If your most recent configuration file is not available, edit a configuration file to reflect the correct value for the **number of devices** parameter.

Edit the runserver file. Add the **-c** parameter to the end of the **dataserver** or **sqlsrver** command, specifying the name and location of

the configuration file. When Adaptive Server starts, it reads the parameter values from the specified configuration file.

Step Nine: Restart Adaptive Server in Master-Recover Mode

Use **startserver** to restart Adaptive Server in master-recover mode (see "Step Three: Start Adaptive Server in Master-Recover Mode" on page 28-5). Watch for error messages during recovery.

Loading the backup of *master* restores the "sa" account to its previous state. It restores the password on the "sa" account, if one exists. If you used **sp_locklogin** to lock this account before the backup was made, the "sa" account will now be locked. Perform the rest of the recovery steps using an account with the System Administrator role.

Step Ten: Check System Tables to Verify Current Backup of *master*

If you have backed up the *master* database since issuing the most recent **disk init**, **create database**, or **alter database** command, then the contents of *sysusages, sysdatabases*, and *sysdevices* will match your hard copy.

Check the *sysusages, sysdatabases,* and *sysdevices* tables in your recovered server against your hard copy. Look especially for these problems:

- If any devices in your hard copy are not included in the restored *sysdevices,* then you have added devices since your last backup, and you must run **disk reinit** and **disk refit**. For information on using these commands, see "Restoring System Tables with disk reinit and disk refit" on page 28-20.
- If any databases listed in your hard copy are not listed in your restored *sysdatabases* table, you have added a database since the last time you backed up *master.* You must run **disk refit** (see "Restoring System Tables with disk reinit and disk refit" on page 28-20).

Step Eleven: Restart Adaptive Server

Restart Adaptive Server in normal (multiuser) mode.

Step Twelve: Restore Server User IDs

Check your hard copy of *syslogins* and your restored *syslogins* table. Look especially for the following situations and reissue the appropriate commands, as necessary:

- If you have added server logins since the last backup of *master*, reissue the **sp_addlogin** commands.
- If you have dropped server logins, reissue the **sp_droplogin** commands.
- If you have locked server accounts, reissue the **sp_locklogin** commands.
- Check for other differences caused by the use of **sp_modifylogin** by users or by System Administrators.

Make sure that the *suids* assigned to users are correct. Mismatched *suid* values in databases can lead to permission problems, and users may not be able to access tables or run commands.

An effective technique for checking existing *suid* values is to perform a **union** on each *sysusers* table in your user databases. You can include *master* in this procedure, if users have permission to use *master*.

For example:

```
select suid, name from master..sysusers
union
select suid, name from sales..sysusers
union
select suid, name from parts..sysusers
union
select suid, name from accounting..sysusers
```

If your resulting list shows skipped *suid* values in the range where you need to redo the logins, you must add placeholders for the skipped values and then drop them with **sp_droplogin** or lock them with **sp_locklogin.**

Step Thirteen: Restore the *model* Database

Restore the *model* database:

- Load your backup of *model*, if you keep a backup.
- If you do not have a backup:
  - Run the **installmodel** script:

On most platforms:

```
cd $SYBASE/scripts
isql -Usa -Ppassword -Sserver_name < installmodel
```

On Windows NT:

```
cd $SYBASE/scripts
isql -Usa -Ppassword -Sserver_name < instmodl
```

On OpenVMS:

```
set default sybase_system:[sybase.scripts]
define dsquery server_name
isql/user="sa"/password="password"
 /input=installmodel
```

- Redo any changes you made to *model*.

Step Fourteen: Check Adaptive Server

Check Adaptive Server carefully:

1. Compare your hard copy of *sysusages* with the new online version.
2. Compare your hard copy of *sysdatabases* with the new online version.
3. Run **dbcc checkalloc** on each database.
4. Examine the important tables in each database.

◆ ***WARNING!***

If you find discrepancies in *sysusages*, call Sybase Technical Support.

Step Fifteen: Back Up *master*

When you have completely restored the *master* database and have run full **dbcc** integrity checks, back up the database using your usual dump commands.

Recovering the *model* Database

This section describes recovery of the *model* database when only the *model* database needed to be restored. It includes instructions for these scenarios:

- You have not made any changes to *model*, so you need to restore only the generic *model* database.
- You have changed *model*, and you have a backup.
- You have changed *model*, and you do not have a backup.

Restoring the Generic *model* Database

buildmaster can restore the *model* database without affecting *master*.

◆ ***WARNING!***

Shut down Adaptive Server before you use any buildmaster command.

On UNIX platforms:

```
buildmaster -d /devname -x
```

On OpenVMS:

```
buildmaster /disk = physicalname /model
```

On Windows NT:

```
bldmastr -d physicalname -x
```

Restoring *model* from a Backup

If you can issue the **model** successfully, you can restore your *model* database from a backup with **load database**.

If you cannot use the database:

1. Follow the instructions for “Restoring the Generic model Database” on page 28-16.
2. If you have changed the size of *model*, reissue **alter database**.
3. Load the backup with **load database**.

Restoring *model* with No Backup

If you have changed your *model* database, and you do not have a backup:

- Follow the steps for "Restoring the Generic model Database" on page 28-16.
- Reissue all the commands you issued to change *model*.

Recovering the *sybsystemprocs* Database

The *sybsystemprocs* database stores the system procedures that are used to modify and report on system tables. If your routine **dbcc** checks report damage, and you do not keep a backup of this database, you can restore it using **installmaster.** If you do keep backups of *sybsystemprocs*, you can restore it with **load database.**

Restoring *sybsystemprocs* with *installmaster*

1. Check to see what logical device currently stores the database. If you can still use **sp_helpdb**, issue:

   ```
   sp_helpdb sybsystemprocs
   ```

```
name                 db_size       owner            dbid
        created
        status
------------------- ------------- ---------------- ------
sybsystemprocs            28.0 MB sa                    4
        Aug 07, 1993
        trunc log on chkpt

device_fragments   size        usage            free kbytes
------------------ ----------- ---------------- -----------
sprocdev           28.0 MB     data and log            3120
```

   The "device_fragments" column indicates that the database is stored on *sprocdev*.

   If you cannot use **sp_helpdb**, this query reports the devices used by the database and the amount of space on each device:

```
select sysdevices.name, sysusages.size / 512
from sysdevices, sysdatabases, sysusages
where sysdatabases.name = "sybsystemprocs"
  and sysdatabases.dbid = sysusages.dbid
  and sysdevices.low <= sysusages.size + vstart
  and sysdevices.high >= sysusages.size + vstart -1
name
--------------- -------
sprocdev              28
```

2. Drop the database:

   ```
   drop database sybsystemprocs
   ```

   If the physical disk is damaged, use **dbcc dbrepair** to drop the database and then use **sp_dropdevice** to drop the device. If necessary, use **disk init** to initialize a new database device. See Chapter 12, "Initializing Database Devices," for more information on **disk init**.

3. Re-create the *sybsystemprocs* database on the device, using the size returned by the query under step 1:

   ```
   create database sybsystemprocs
       on sprocdev = 28
   ```

➤ ***Note***

The required size for *sybsystemprocs* may be different for your operating system. See the installation documentation for your platform for the correct size.

4. Run the **installmaster** script.

◆ ***WARNING!***

Running *installmaster* repeatedly can change the distribution of index values in such a way that the *sysprocedures* table will require much more disk space to store the same amount of data. To avoid this problem, drop and re-create *sybsystemprocs* before running *installmaster*.

On UNIX platforms:

```
cd $SYBASE/scripts
isql -Usa -Ppassword -Sserver_name < installmaster
```

On OpenVMS:

```
set default sybase_system:[sybase.scripts]
define dsquery server_name
isql/user="sa"/password="password"
     /input=installmaster
```

On Windows NT:

```
cd $SYBASE/scripts
isql -Usa -Ppassword -Sserver_name < instmstr
```

5. If you have made any changes to permissions in *sybsystemprocs*, or if you have added your own procedures to the database, you must redo the changes.

Restoring *sybsystemprocs* with *load database*

If you write system procedures and store them in *sybsystemprocs*, there are two ways to recover them if the database is damaged:

- Restore the database from **installmaster**, as described in step 4 under "Restoring sybsystemprocs with installmaster" on page 28-17. Then re-create the procedures by reissuing the **create procedure** commands.
- Keep backups of the database, and load them with **load database.**

If you choose to keep a backup of the database, be sure that the complete backup fits on one tape volume or that more than one Adaptive Server is able to communicate with your Backup Server. If a dump spans more than one tape volume, issue the change-of-volume command using **sp_volchanged**, which is stored in *sybsystemprocs.* You cannot issue that command in the middle of recovering a database.

Following are sample load commands:

On UNIX:

```
load database sybsystemprocs from "/dev/nrmt4"
```

On OpenVMS:

```
load database sybsytemprocs from "MTA0:"
```

On Windows NT:

```
load database sybsystemprocs from "\\.\TAPE0"
```

Restoring System Tables with *disk reinit* and *disk refit*

When you are restoring the *master* database from a dump that does not reflect the most recent **disk init** or **create database** and **alter database** commands, follow the procedures in this section to restore the proper information in the *sysusages*, *sysdatabases*, and *sysdevices* tables.

Restoring *sysdevices* with *disk reinit*

If you have added any database devices since the last dump—that is, if you have issued a **disk init** command—you must add each new device to *sysdevices* with **disk reinit**. If you saved scripts from your original **disk init** commands, use them to determine the parameters for **disk reinit** (including the original value of *vstart*). If the size you provide is too small, or if you use a different *vstart* value, you may corrupt your database.

If you did not save your **disk init** scripts, look at your most recent hard copy of *sysdevices* to determine some of the correct parameters for **disk reinit**. You will still need to know the value of *vstart* if you used a custom *vstart* in the original **disk init** command.

Table 28-1 describes the **disk reinit** parameters and their corresponding *sysdevices* data:

Table 28-1: Using sysdevices to determine disk reinit parameters

disk reinit Parameter	*sysdevices* Data	Notes
name	*name*	Use the same name, especially if you have any scripts that create or alter databases or add segments.
physname	*phyname*	Must be full path to device.
vdevno	*low* / 16777216	Not necessary to use the same value for *vdevno*, but be sure to use a value not already in use.
size	(*high*-*low*) +1	Extremely important to provide correct size information.

You can also obtain information on devices by reading the error log for *name*, *physname*, and *vdevno*, and using operating system commands to determine the size of the devices.

If you store your *sybsystemprocs* database on a separate physical device, be sure to include a **disk reinit** command for *sybsystemprocs*, if it is not listed in *sysdevices*.

After running **disk reinit**, compare your *sysdevices* table to the copy you made before running **buildmaster**.

disk reinit can be run only from the *master* database and only by a System Administrator. Permission cannot be transferred to other users. Its syntax is:

```
disk reinit
      name = "device_name",
      physname = "physical_name",
      vdevno = virtual_device_number,
      size = number_of_blocks
      [, vstart = virtual_address,
      cntrltype = controller_number]
```

For more information on **disk reinit**, see the discussion of **disk init** in Chapter 12, "Initializing Database Devices," or the *Adaptive Server Reference Manual*.

Restoring *sysusages* and *sysdatabase* with *disk refit*

If you have added database devices or created or altered databases since the last database dump, use **disk refit** to rebuild the *sysusages* and *sysdatabases* tables.

disk refit can be run only from the *master* database and only by a System Administrator. Permission cannot be transferred to other users. Its syntax is:

```
disk refit
```

Adaptive Server shuts down after **disk refit** rebuilds the system tables. Examine the output while **disk refit** runs and during the shutdown process to determine whether any errors occurred.

◆ ***WARNING!***

Providing inaccurate information in the disk reinit command may lead to permanent corruption when you update your data. Be sure to check Adaptive Server with dbcc after running disk refit.

29 Managing Free Space with Thresholds

When you create or alter a database, you allocate a finite amount of space for its data and log segments. As you create objects and insert data, the amount of free space in the database decreases.

This chapter explains how to use thresholds to monitor the amount of free space in a database segment. Topics include:

Monitoring Free Space with the Last-Chance Threshold

All databases have a **last-chance threshold**, including *master*. The threshold is an estimate of the number of free log pages that are required to back up the transaction log. As you allocate more space to the log segment, Adaptive Server automatically adjusts the last-chance threshold.

When the amount of free space in the log segment falls below the last-chance threshold, Adaptive Server automatically executes a special stored procedure called **sp_thresholdaction**. (You can specify a different last-chance threshold procedure with **sp_modifythreshold**.)

Figure 29-1 illustrates a log segment with a last-chance threshold. The shaded area represents log space that has already been used; the unshaded area represents free log space. The last-chance threshold has not yet been crossed.

Figure 29-1: Log segment with a last-chance threshold

Crossing the Threshold

As users execute transactions, the amount of free log space decreases. When the amount of free space crosses the last-chance threshold, Adaptive Server executes **sp_thresholdaction**:

Figure 29-2: Executing sp_thresholdaction when the last-chance threshold is reached

Controlling How Often *sp_thresholdaction* Executes

Adaptive Server uses a **hysteresis value**, the global variable *@@thresh_hysteresis*, to control how sensitive thresholds are to variations in free space.

A threshold is deactivated after it executes its procedure, and remains inactive until the amount of free space in the segment rises *@@thresh_hysteresis* pages above the threshold. This prevents thresholds from executing their procedures repeatedly in response to minor fluctuations in free space. You cannot change the value of *@@thresh_hysteresis*.

For example, when the threshold in Figure 29-2 executes **sp_thresholdaction**, it is deactivated. In Figure 29-3, the threshold is reactivated when the amount of free space increases by the value of *@@thresh_hysteresis*:

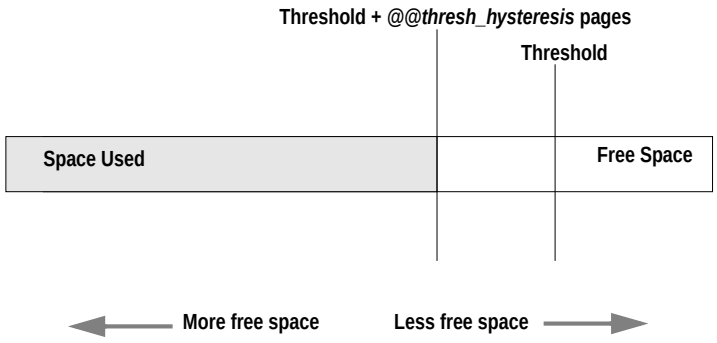


Figure 29-3: Free space must rise by @@thresh_hysteresis to reactivate threshold

Rollback Records and the Last-Chance Threshold

Adaptive Server version 11.9 and later include **rollback records** in the transaction logs. Rollback records are logged whenever a transaction is rolled back.

Servers save enough space to log a rollback record for every update belonging to an open transaction. If a transaction completes successfully, no rollback records are logged and the space reserved for them is released.

To calculate the increased amount of space to be added to a transaction log to accommodate rollback records, estimate:

- The number of update records in the transaction log that are likely to belong to already rolled-back transactions
- The maximum number of update records in the transaction log that are likely to belong to open transactions at any one time

Each rollback record requires approximately 60 bytes of space, or 3 one hundredths of a page. Thus, the calculation for including rollback records (RRs) in the transaction log is:

Added space, in pages = (logged RRs + # open updates) X 3 / 100

You may also want to add log space to compensate for the effects of rollback records on the last-chance threshold and on user-defined thresholds, as described in the following sections.

Effect of Rollback Records on the Last-Chance Threshold

Adaptive Servers that use rollback records must reserve additional room for the last-chance threshold. The last-chance threshold ("LCT") is also likely to be reached sooner because of the space used by already logged rollback records and the space reserved against open transactions for potential rollback records. Figure 29-4 illustrates how space is used in a transaction log with rollback records:

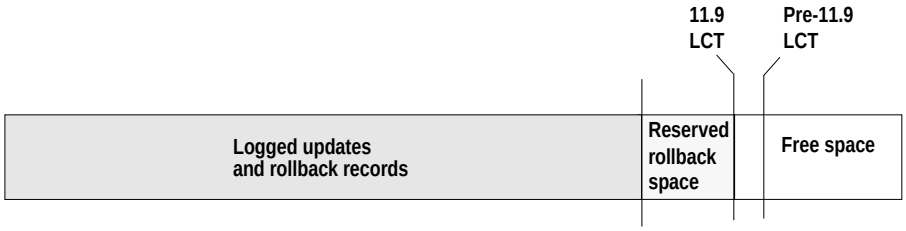


Figure 29-4: Space used in log with rollback records

In Figure 29-4, in the 11.9 Adaptive Server, log space is occupied by logged rollback records for closed transactions that did not complete successfully. In addition, space is reserved for rollback records that may need to be logged, if any of the currently open transactions do not complete successfully. Together, the space for logged rollback records and for potential rollback records is likely to be considerably greater than the extra space for the last-chance threshold. Consequently, transaction logs that use rollback records reach the last-chance threshold significantly sooner than transaction logs that do not use rollback records, even if the size of the transaction log is not increased.

In general, about 18 percent more log space is reserved for the last-chance threshold in 11.9 and later Adaptive Servers than in earlier versions. For example, for a transaction log of 5000 pages, version 11.5 reserves 264 pages and version 11.9 reserves 312 pages. This is an increase of 18.18 percent between version 11.5 and 11.9.

User-Defined Thresholds

Because rollback records occupy extra space in the transaction log, there is less free space after the user-defined threshold for completing a dump than in versions of Adaptive Server that do not use rollback records (See Figure 29-4). However, the loss of space for a dump because of the increased last-chance threshold is likely to be more than compensated for by the space reserved for rollback records for open transactions.

Upgrading to version that uses rollback records affects user-defined thresholds similarly to the way it effects last-chance thresholds. Figure 29-5 illustrates the effect of upgrading to an Adaptive Server using rollback records on a user-defined threshold:

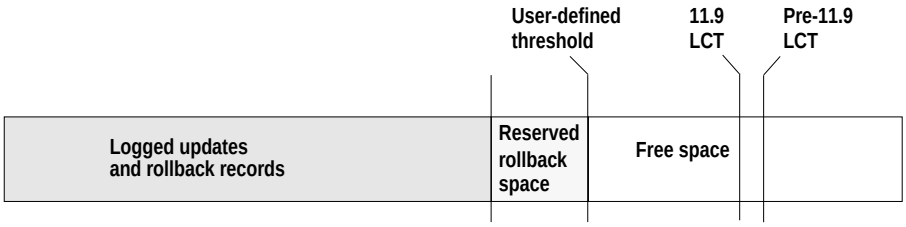


Figure 29-5: Effect of upgrading on user-defined thresholds

A user-defined threshold such as the one in Figure 29-5 is often used to initiate a **dump transaction.** The threshold is set so there is enough room to complete the dump before the last-chance threshold is reached and all open transactions in the log are suspended.

In databases that use mixed log and data, the last-chance threshold moves dynamically, and its value can be automatically configured to be less than the user-defined threshold. If this happens, the user-defined threshold is disabled, and the last chance threshold fires

before the user-defined threshold is reached, as shown in Figure 29-6:**Dynamically configured last-chance threshold**

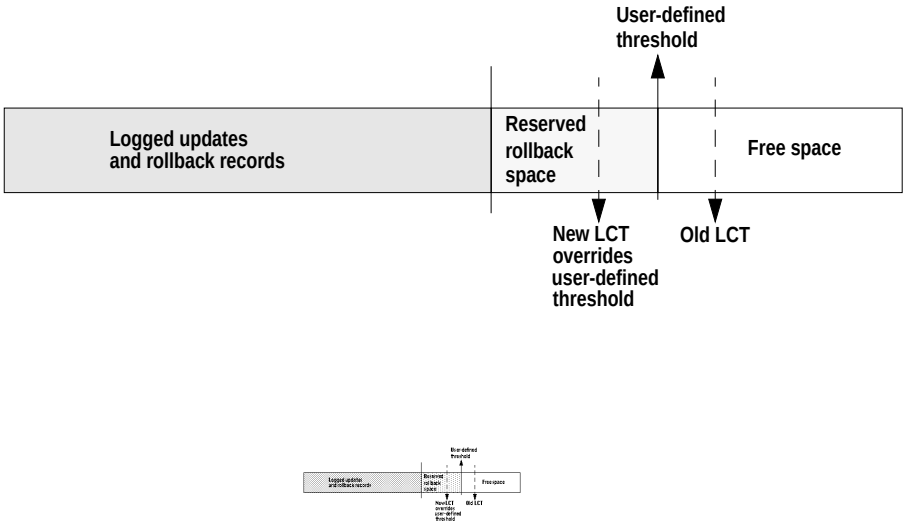


Figure 29-6: LCT firing before user-defined threshold

The user-defined threshold is re-enabled if the value of last-chance threshold is configured to be greater than the user-defined threshold (for example, if the last chance threshold is reconfigured for the value of "Old LCT" in Figure 29-6).

In databases with a separate log segment, the log has a dedicated amount of space and the last-chance threshold is static. The user-defined threshold is not affected by the last-chance threshold.

Last-Chance Threshold and User Log Caches for Shared Log and Data Segments

Every database in an Adaptive Server has a last-chance threshold and all databases allow transactions to be buffered in a user log cache. When you initially create a database with shared log and data segments, its last-chance threshold is based on the size of the *model* database. As soon as data is added and logging activity begins, the last-chance threshold is recalculated dynamically, based on available space and currently open transactions. The last-chance threshold of a

database with separate log and data segments is based on the size of the log segment and does not vary dynamically.

To get the current last-chance threshold of any database, you can use **lct_admin** with the **reserve** parameter and a specification of 0 log pages:

```
select lct_admin("reserve",0)
```

The last-chance threshold for a database is stored in the *systhresholds* table and is also accessible through **sp_helpthreshold**. However, note that:

- **sp_helpthreshold** returns user-defined thresholds and other data, as well as an up-to-date value for the last-chance threshold. Using **lct_admin** is simpler if you need only the current last-chance threshold. Either of these values produce the most current value for the last-chance threshold.
- For a database with shared log and data segments, the last-chance threshold value in *systhresholds* may **not** be the current last-chance threshold value.

Reaching Last-Chance Threshold Suspends Transactions

The default behavior of Adaptive Server is to suspend open transactions until additional log space is created. Transactions suspended because of the last-chance threshold can be terminated using the **abort** parameter of the **lct_admin** system function, described in "Using lct_admin abort To Abort Suspended Transactions," below. For information about configuring Adaptive Server to automatically abort suspended processes, see "Automatically Aborting or Suspending Processes" on page 29-9.

Using *lct_admin abort* To Abort Suspended Transactions

When the transaction log reaches the last-chance threshold, all becomes made available. Typically, space is created by dumping the transaction log, since this removes committed transactions from the beginning of the log. However, if one or more transactions at the beginning of the log is still open, it prevents a dump of the transaction log.

Use **lct_admin abort** to terminate suspended transactions that are preventing a transaction log dump. Since terminating a transaction

closes it, this allows the dump to proceed. Figure 29-7 illustrates a possible scenario for using **lct_admin abort**:

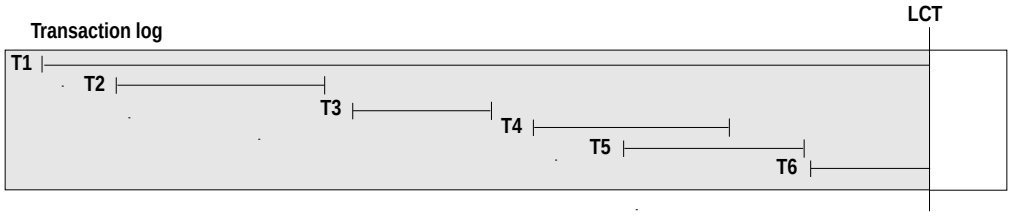


Figure 29-7: Example of when to use of lct_admin abort

In Figure 29-7, a transaction log has reached its LCT, and open transactions T1 and T6 are suspended. Because T1 is at the beginning of the log, it prevents a dump from removing closed transactions T3 through T5 and creating space for continued logging. Terminating T1 with **lct_admin abort** allows you to close T1 so that a dump can clear transactions T1 through T5 from the log.

lct_admin abort replaces **lct_admin unsuspend.**

lct_admin abort Syntax

The syntax for **lct_admin abort** is:

```
lct_admin("abort", {process_id [, database_id]})
```

Before you can abort a transaction, you must first determine its ID. See "Getting the Process ID for the Oldest Open Transaction," below for information about determining the transaction's pid.

To terminate the oldest transaction, enter the process ID (*spid*) of the process that initiated the transaction. This also terminates any other suspended transactions in the log that belong to the specified process.

For example, if process 83 holds the oldest open transaction in a suspended log, and you want to terminate the transaction, enter:

```
select lct_admin("abort", 83)
```

This also terminates any other open transactions belonging to process 83 in the same transaction log.

To terminate all open transactions in the log, enter:

```
select lct_admin("abort", 0, 12)
```

Getting the Process ID for the Oldest Open Transaction

Use the following query to find the *spid* of the oldest open transaction in a transaction log that has reached its last-chance threshold:

```
use master
go
select dbid, spid from syslogshold
where dbid = db_id("name_of_database")
```

For example, to find the oldest running transaction on the *pubs2* database:

```
select dbid, spid from syslogshold
where dbid = db_id ("pubs2")
dbid   spid
------ ------
    7      1
```

Using *alter database* When the Master Database Reaches the Last-Chance Threshold

When the last-chance threshold on the *master* database is reached, you can use **alter database** to add space to the *master* database's transaction log. This allows more activity in the server by causing suspended transactions in the log to become active. However, while the master transaction log is at its last-chance threshold, you cannot use **alter database** to make changes in other databases. Thus, if both *master* and another database reach their last-chance thresholds, you would first need to use **alter database** to add log space to the *master* database, and then use it again to add log space to the second database.

Automatically Aborting or Suspending Processes

By design, the last-chance threshold allows enough free log space to record a **dump transaction** command. There may not be enough room to record additional user transactions against the database.

When the last-chance threshold is crossed, Adaptive Server suspends user processes and displays the message:

```
Space available in the log segment has fallen
critically low in database 'mydb'. All future
modifications to this database will be suspended
until the log is successfully dumped and space
becomes available.
```

Only commands that are not recorded in the transaction log (**select** or **readtext)** and commands that might be necessary to free additional log space (**dump transaction**, **dump database**, and **alter database**) can be executed.

Using *abort tran on log full* to Abort Transactions

To configure the last-chance threshold to automatically abort open transactions, rather than suspend them:

```
sp_dboption database_name "abort tran on log full",
   true
```

If you upgrade from a previous version of Adaptive Server, the newly upgraded server retains the **abort tran on log full** setting.

Waking Suspended Processes

After **dump transaction** frees sufficient log space, suspended processes automatically awaken and complete. If **writetext** or **select into** has resulted in unlogged changes to the database since the last backup, the last-chance threshold procedure cannot execute **dump transaction**. When this occurs, make a copy of the database with **dump database**, then truncate the log with **dump transaction**.

If this does not free enough space to awaken the suspended processes, you may need to increase the size of the transaction log. Use the **log on** option of **alter database** to allocate additional log space.

As a last resort, System Administrators can use the **sp_who** command to determine which processes are in a log suspend status and then use the **kill** command to kill the sleeping process.

Adding, Changing, and Deleting Thresholds

The Database Owner or System Administrator can create additional thresholds to monitor free space on any segment in the database. Additional thresholds are called **free-space thresholds**. Each database can have up to 256 thresholds, including the last-chance threshold.

sp_addthreshold, **sp_modifythreshold**, and **sp_dropthreshold** allow you to create, change, and delete thresholds. To prevent users from accidentally affecting thresholds in the wrong database, these procedures require that you specify the name of the current database.

Displaying Information About Existing Thresholds

Use **sp_helpthreshold** to get information about all thresholds in a database. Use **sp_helpthreshold** ***segment_name*** **to get** information about the thresholds on a particular segment.

The following example displays information about the thresholds on the database's default segment. Since "default" is a reserved word, you must enclose it in quotation marks. The output of **sp_helpthreshold** shows that there is one threshold on this segment set at 200 pages. The 0 in the "last chance" column indicates that this is a free-space threshold instead of a last-chance threshold:

```
sp_helpthreshold "default"
segment name   free pages   last chance?   threshold procedure
------------   ----------   ------------   -------------------
default        200                     0   space_dataseg

(1 row affected, return status = 0)
```

Thresholds and System Tables

The system table *systhresholds* holds information about thresholds. **sp_helpthreshold** uses this table to provide its information. In addition to information about segment name, free page, last-chance status, and the name of the threshold procedure, the table also records the server user ID of the user who created the threshold and the roles had at the moment the threshold was created.

Adaptive Server gets information about how much free space is remaining in a segment—and whether to activate a threshold—from the built-in system function **curunreservedpgs().**

Adding a Free-Space Threshold

Use **sp_addthreshold** to create free-space thresholds. Its syntax is:

sp_addthreshold ***dbname, segname, free_space, proc_name***

The *dbname* must specify the name of the current database. The remaining parameters specify the segment whose free space is being monitored, the size of the threshold in database pages, and the name of a stored procedure.

When the amount of free space on the segment falls below the threshold, an internal Adaptive Server process executes the associated procedure. This process has the permissions of the user who created the threshold when he or she executed **sp_addthreshold**, less any permissions that have since been revoked.

Thresholds can execute a procedure in the same database, in another user database, in *sybsystemprocs*, or in *master*. They can also call a remote procedure on an Open Server. **sp_addthreshold** does not verify that the threshold procedure exists when you create the threshold.

Changing a Free-Space Threshold

Use **sp_modifythreshold** to associate a free-space threshold with a new threshold procedure, free-space value, or segment. **sp_modifythreshold** drops the existing threshold and creates a new one in its place. Its syntax is:

```
sp_modifythreshold dbname, segname, free_space
   [, new_proc_name [, new_free_space
   [, new_segname]]]
```

where *dbname* is the name of the current database, and *segname* and *free_space* identify the threshold that you want to change.

For example, to execute a threshold procedure when free space on the segment falls below 175 pages rather than below 200 pages, enter:

```
sp_modifythreshold mydb, "default", 200, NULL, 175
```

In this example, NULL acts as a placeholder so that *new_free_space* falls in the correct place in the parameter list. The name of the threshold procedure is not changed.

The person who modifies the threshold becomes the new threshold owner. When the amount of free space on the segment falls below the threshold, Adaptive Server executes the threshold procedure with the owner's permissions at the time he or she executed **sp_modifythreshold**, less any permissions that have since been revoked.

Specifying a New Last-Chance Threshold Procedure

You can use **sp_modifythreshold** to change the name of the procedure associated with the last-chance threshold. You **cannot** use it to change the amount of free space or the segment name for the last-chance threshold.

sp_modifythreshold requires that you specify the number of free pages associated with the last-chance threshold. Use **sp_helpthreshold** to determine this value.

The following example displays information about the last-chance threshold, and then specifies a new procedure, **sp_new_thresh_proc**, to execute when the threshold is crossed:

```
sp_helpthreshold logsegment
segment name   free pages   last chance?   threshold procedure
------------   ----------   ------------   -------------------
logsegment     40                      1   sp_thresholdaction

(1 row affected, return status = 0)
sp_modifythreshold mydb, logsegment, 40,
sp_new_thresh_proc
```

Dropping a Threshold

Use **sp_dropthreshold** to remove a free-space threshold from a segment. Its syntax is:

```
sp_dropthreshold dbame, segname, free_space
```

The *dbname* must specify the name of the current database. You must specify both the segment name and the number of free pages, since there can be several thresholds on a particular segment. For example:

```
sp_dropthreshold mydb, "default", 200
```

Creating a Free-Space Threshold for the Log Segment

When the last-chance threshold is crossed, all transactions are aborted or suspended until sufficient log space is freed. In a production environment, this can have a heavy impact on users. Adding a correctly placed free-space threshold on your log segment can minimize the chances of crossing the last-chance threshold.

The additional threshold should dump the transaction log often enough that the last-chance threshold is rarely crossed. It should not

dump it so often that restoring the database requires the loading of too many tapes.

This section helps you determine the best place for a second log threshold. It starts by adding a threshold with a *free_space* value set at 45 percent of log size and adjusts this threshold based on space usage at your site.

Adding a Log Threshold at 45 Percent of Log Size

Use the following procedure to add a log threshold with a *free_space* value set at 45 percent of log size.

1. Determine the log size in pages:

   ```
   select sum(size)
   from master..sysusages
   where dbid = db_id("database_name")
   and (segmap & 4) = 4
   ```

2. Use **sp_addthreshold** to add a new threshold with a *free_space* value set at 45 percent. For example, if the log's capacity is 2048 pages, add a threshold with a *free_space* value of 922 pages:

   ```
   sp_addthreshold mydb, logsegment, 922, thresh_proc
   ```

3. Create a simple threshold procedure that dumps the transaction log to the appropriate devices. For more information about creating threshold procedures, see "Creating Threshold Procedures" on page 29-18.

Testing and Adjusting the New Threshold

Use **dump transaction** to make sure your transaction log is less than 55 percent full. Then use the following procedure to test the new threshold:

1. Fill the transaction log by simulating routine user action. Use automated scripts that perform typical transactions at the projected rate.

   When the 45 percent free-space threshold is crossed, your threshold procedure will dump the transaction log. Since this is not a last-chance threshold, transactions will not be suspended or aborted; the log will continue to grow during the dump.

2. While the dump is in progress, use **sp_helpsegment** to monitor space usage on the log segment. Record the maximum size of the transaction log just before the dump completes.
3. If considerable space was left in the log when the dump completed, you may not need to dump the transaction log so soon, as shown in Figure 29-8:

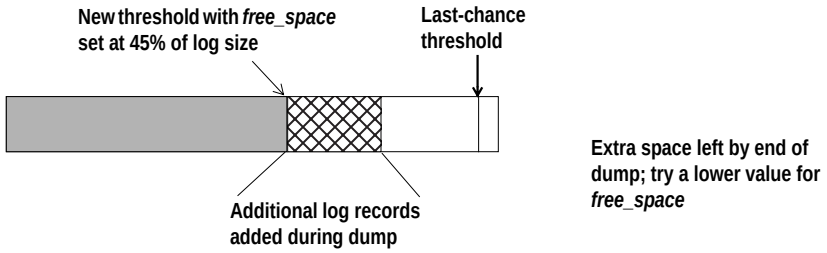


Figure 29-8: Transaction log with additional threshold at 45 percent

Try waiting until only 25 percent of log space remains, as shown in Figure 29-9:

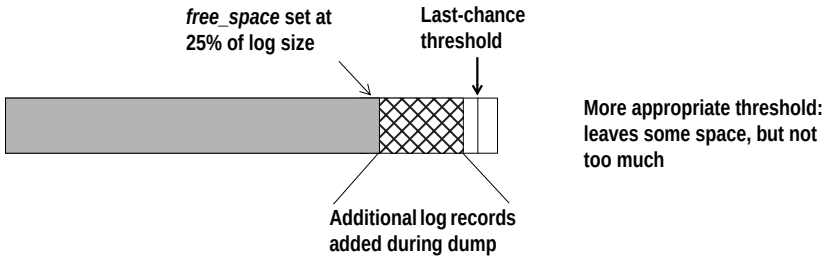


Figure 29-9: Moving threshold leaves less free space after dump

Use **sp_modifythreshold** to adjust the *free_space* value to 25 percent of the log size. For example:

```
sp_modifythreshold mydb, logsegment, 512,
    thresh_proc
```

4. Dump the transaction log and test the new *free_space* value. If the last-chance threshold is crossed before the dump completes, you are not beginning the **dump transaction** soon enough, as shown in Figure 29-10:

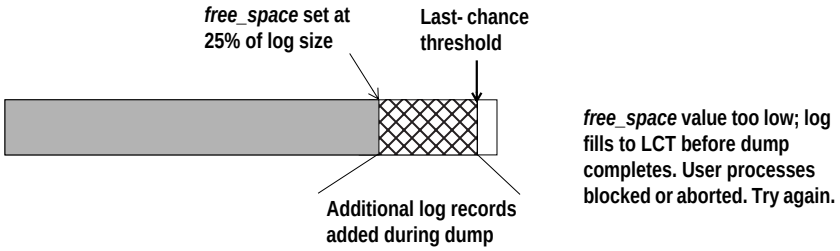


Figure 29-10:Additional log threshold does not begin dump early enough

25 percent free space is not enough. Try initiating the dump transaction when the log has 37.5 percent free space, as shown in Figure 29-11:

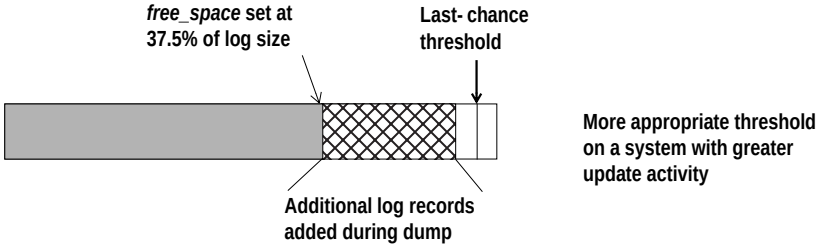


Figure 29-11:Moving threshold leaves enough free space to complete dump

Use **sp_modifythreshold** to change the *free_space* value to 37.5 percent of log capacity. For example:

```
sp_modifythreshold mydb, logsegment, 768,
    thresh_proc
```

Creating Additional Thresholds on Other Segments

You can create free-space thresholds on data segments as well as on log segments. For example, you might create a free-space threshold on the default segment used to store tables and indexes. You would also create an associated stored procedure to print messages in your error log when space on the *default* segment falls below this threshold. If you monitor the error log for these messages, you can add space to the database device before your users encounter problems.

The following example creates a free-space threshold on the *default* segment of *mydb*. When the free space on this segment falls below 200 pages, Adaptive Server executes the procedure *space_dataseg*:

```
sp_addthreshold mydb, "default", 200, space_dataseg
```

Determining Threshold Placement

Each new threshold must be at least twice the *@@thresh_hysteresis* value from the next closest threshold, as shown in Figure 29-12:

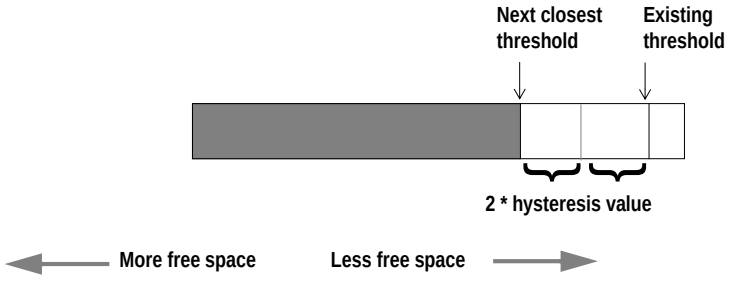


Figure 29-12:Determining where to place a threshold

To see the hysteresis value for a database, use:

```
select @@thresh_hysteresis
```

In this example, a segment has a threshold set at 100 pages, and the hysteresis value for the database is 64 pages. The next threshold must be at least 100 + (2 * 64), or 228 pages.

```
select @@thresh_hysteresis

-----------
         64
```

```
sp_addthreshold user_log_dev, 228,
    sp_thresholdaction
```

Creating Threshold Procedures

Sybase does not supply threshold procedures. You must create these procedures yourself to ensure that they are tailored to your site's needs.

Suggested actions for a threshold procedure include writing to the server's error log and dumping the transaction log to increase the amount of log space. You can also execute remote procedure calls to an Open Server or to XP Server. For example, if you include the following command in **sp_thresholdaction**, it executes the procedure **mail_me** on an Open Server:

```
exec openserv...mail_me @dbname, @segment
```

See Chapter 15, "Using Extended Stored Procedures," in the *Transact-SQL User's Guide* for more information on using extended stored procedures and XP Server.

This section provides some guidelines for writing threshold procedures, as well as two sample procedures.

Declaring Procedure Parameters

Adaptive Server passes four parameters to a threshold procedure:

- *@dbname*, *varchar(30)*, which contains the database name
- *@segmentname*, *varchar(30)*, which contains the segment name
- *@space_left*, *int*, which contains the space-left value for the threshold
- *@status*, *int*, which has a value of 1 for last-chance thresholds and 0 for other thresholds

These parameters are passed by position rather than by name. Your procedure can use other names for these parameters, but must declare them in the order shown and with the datatypes shown.

Generating Error Log Messages

You should include a **print** statement near the beginning of your procedure to record the database name, segment name, and threshold size in the error log. If your procedure does not contain a

print or **raiserror** statement, the error log will not contain any record of the threshold event.

The process that executes threshold procedures is an internal Adaptive Server process. It does not have an associated user terminal or network connection. If you test your threshold procedures by executing them directly (that is, using **execute** ***procedure_name***) during a terminal session, you see the output from the **print** and **raiserror** messages on your screen. When the same procedures are executed by reaching a threshold, the messages go to the error log. The messages in the log include the date and time.

For example, if **sp_thresholdaction** includes this statement:

```
print "LOG DUMP: log for '%1!' dumped", @dbname
```

Adaptive Server writes this message to the error log:

```
00: 92/09/04 15:44:23.04 server: background task message: LOG
DUMP: log for 'pubs2' dumped
```

Dumping the Transaction Log

If your **sp_thresholdaction** procedure includes a **dump transaction** command, Adaptive Server dumps the log to the devices named in the procedure. **dump transaction** truncates the transaction log by removing all pages from the beginning of the log, up to the page just before the page that contains an uncommitted transaction record.

When there is enough log space, suspended transactions are awakened. If you abort transactions rather than suspending them, users must resubmit them.

Generally, dumping to a disk is **not** recommended, especially to a disk that is on the same machine or the same disk controller as the database disk. However, since threshold-initiated dumps can take place at any time, you may want to dump to disk and then copy the resulting files to offline media. (You will have to copy the files back to the disk to reload them.)

Your choice will depend on:

- Whether you have a dedicated dump device online, loaded and ready to receive dumped data
- Whether you have operators available to mount tape volumes during the times when your database is available
- The size of your transaction log
- Your transaction rate

- Your regular schedule for dumping databases and transaction logs
- Available disk space
- Other site-specific dump resources and constraints

A Simple Threshold Procedure

Following is a simple procedure that dumps the transaction log and prints a message to the error log. Because this procedure uses a variable (*@dbname*) for the database name, it can be used for all databases in Adaptive Server:

```
create procedure sp_thresholdaction
    @dbname varchar(30),
    @segmentname varchar(30),
    @free_space int,
    @status int
as
dump transaction @dbname
    to tapedump1
print "LOG DUMP: '%1!' for '%2!' dumped",
        @segmentname, @dbname
```

A More Complex Procedure

The following threshold procedure performs different actions, depending on the value of the parameters passed to it. Its conditional logic allows it to be used with both log and data segments.

The procedure:

- Prints a "LOG FULL" message if the procedure was called as the result of reaching the log's last-chance threshold. The status bit is 1 for the last-chance threshold and 0 for all other thresholds. The test **if (@status&1) = 1** returns a value of "true" only for the last-chance threshold.
- Verifies that the segment name provided is the log segment. The segment ID for the log segment is always 2, even if the name has been changed.
- Prints "before" and "after" size information on the transaction log. If the log did not shrink significantly, a long-running transaction may be causing the log to fill.

- Prints the time the transaction log dump started and stopped, helping gather data about dump durations.
- Prints a message in the error log if the threshold is not on the log segment. The message gives the database name, the segment name and the threshold size, letting you know that the data segment of a database is filling up.

```
create procedure sp_thresholdaction
     @dbname           varchar(30),
     @segmentname      varchar(30),
     @space_left       int,
     @status           int
as
declare @devname varchar(100),
           @before_size int,
           @after_size int,
           @before_time datetime,
           @after_time datetime,
           @error int

/*
** if this is a last-chance threshold, print a LOG FULL msg
** @status is 1 for last-chance thresholds,0 for all others
*/
if (@status&1) = 1
begin
      print "LOG FULL: database '%1!'", @dbname
end

/*
** if the segment is the logsegment, dump the log
** log segment is always "2" in syssegments
*/
if @segmentname = (select name from syssegments
               where segment = 2)
begin
     /* get the time and log size
     ** just before the dump starts
     */
     select  @before_time = getdate(),
        @before_size = reserved_pgs(id, doampg)
      from sysindexes
```

```
        where sysindexes.name = "syslogs"

        print "LOG DUMP: database '%1!', threshold '%2!'",
          @dbname, @space_left

        select @devname = "/backup/" + @dbname + "_" +
          convert(char(8), getdate(),4) + "_" +
          convert(char(8), getdate(), 8)

        dump transaction @dbname to @devname

        /* error checking */
        select @error = @@error
        if @error != 0
        begin
             print "LOG DUMP ERROR: %1!", @error
        end

        /* get size of log and time after dump */
        select @after_time = getdate(),
             @after_size = reserved_pgs(id, doampg)
             from sysindexes
             where sysindexes.name = "syslogs"

        /* print messages to error log */
        print "LOG DUMPED TO: device '%1!", @devname
        print "LOG DUMP PAGES: Before: '%1!', After '%2!'",
             @before_size, @after_size
        print "LOG DUMP TIME: %1!, %2!", @before_time, @after_time
end          /* end of 'if segment = 2' section */
else         /* this is a data segment, print a message */
begin
        print "THRESHOLD WARNING: database '%1!', segment '%2!' at
'%3!' pages", @dbname, @segmentname, @space_left
end
```

Deciding Where to Put a Threshold Procedure

Although you can create a separate procedure to dump the transaction log for each threshold, it is easier to create a single threshold procedure that is executed by all log segment thresholds. When the amount of free space on a segment falls below a threshold, Adaptive Server reads the *systhresholds* table in the affected database for the name of the associated stored procedure, which can be any of:

- A remote procedure call to an Open Server

- A procedure name qualified by a database name (for example, *sybsystemprocs.dbo.sp_thresholdaction*)
- An unqualified procedure name

If the procedure name does not include a database qualifier, Adaptive Server looks in the database where the shortage of space occurred. If it cannot find the procedure there, and if the procedure name begins with the characters "sp_", Adaptive Server looks for the procedure in the *sybsystemprocs* database and then in *master* database.

If Adaptive Server cannot find the threshold procedure, or cannot execute it, it prints a message in the error log.

Disabling Free-Space Accounting for Data Segments

Use the **no free space acctg** option to **sp_dboption**, followed by the **checkpoint** command, to disable free-space accounting on non-log segments. You **cannot** disable free-space accounting on the log segment.

When you disable free-space accounting, only the thresholds on your log segment monitor space usage; threshold procedures on your data segments will not execute when these holds are crossed. Disabling free-space accounting speeds recovery time because free-space counts are not recomputed during recovery for any segment except the log segment.

The following example turns off free-space accounting for the *production* database:

```
sp_dboption production,
     "no free space acctg", true
```

◆ ***WARNING!***

If you disable free-space accounting, system procedures cannot provide accurate information about space allocation.

Index

The index is divided into three sections:

- Symbols

  Indexes each of the symbols used in this manual.
- Numerics

  Indexes entries that begin numerically.
- Subjects

  Indexes subjects alphabetically.

Page numbers in **bold** are primary references.

Symbols

Numerics

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