3745 Communication Controller Model A
3746 Nways Multiprotocol Controller
Models 900 and 950

IBM

Planning Series:

Token-Ring and Ethernet

GA27-4236-01

3745 Communication Controller Model A
3746 Nways Multiprotocol Controller
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Note!

Before using this information and the product it supports, be sure to read the general information under "Notices" on page ix.

Second Edition (September 2000)

This edition applies to the 3745 Communication Controller Models A and 3746 Nways® Multiprotocol Controller Models 900 and 950.

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Contents

Figures

Tables

Notices

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For more information, refer to:

`http://www.ibm.com/year2000`

The 3745 and 3746 controllers require a certain level of microcode to be Year 2000 ready. For more detailed information, access the URL listed above and click **Product Readiness**.

What Is New in this Book

This book has been revised to include the following changes and enhancements:

- Support for dynamic windowing on Token-Ring Processors Type 3 (TRP3), allowing the NNP and NCP to regulate traffic over token-ring ports more efficiently.
- An increase (from 3000 to 4000) in the number of token-ring physical units (PUs) that the TRP3 can connect simultaneously.

The technical changes and additions are indicated by a vertical line (|) to the left of the change.

About this Guide

The *3745/3746 Planning Series* is designed to help you plan the installation and configuration of the IBM 3745 Communication Controller Models A and IBM 3746 Nways® Multiprotocol Controller Models 900 and 950. The *Planning Series* also describes the information you must gather to install and integrate 3746 Controllers into Advanced Peer-to-Peer Networking®/High-Performance Routing (APPN®/HPR) and Internet Protocol (IP) environments.

The *3745/3746 Planning Series* consists of a set of Planning Guides that replace, update and obsolete the *Planning Guide*.

Important:

1. If you already use the existing *Planning Guide*, IBM recommends that you read the new *Planning Series* to learn about new features and to become familiar with the new structure in which planning information is presented.
2. When planning the installation and configuration of 3746 controllers you must use the *IBM 3745 Communication Controller Models A, IBM 3746 Nways Multiprotocol Controller, Models 900 and 950: Overview* along with the *3745/3746 Planning Series* to have all required information.
3. The 3745/3746 documentation is updated periodically in response to your needs and to reflect product evolutions. Because of the time delay necessary to update hard media (books that are printed and available on CD-ROM), it is highly recommended that you check periodically the IBM 3745/3746 documentation on the Web for the latest versions of the documents (see “Additional Information on the Web” on page xix).

Refer to the appropriate Planning Guide for the parameters to be customized for the installation and operation of:

- 3745 Communication Controller Models A
- 3746 Nways Multiprotocol Controller Models 900 and 950
- Network Node Processor (NNP)
- Multiaccess Enclosure (MAE)
- Service processor
- Distributed Console Access Facility (DCAF) and TME® 10 remote consoles
- Java™ Console
- Network management

When you define 3746 resources controlled by NCP, record the information in the worksheets provided for the Controller Configuration and Management application.

The *3745/3746 Planning Series* consists of the following planning guides:

Overview, Installation, and Integration

Starts with a general overview of 3746 planning and then explains the various 3745 and 3746 installation and upgrade scenarios.

The guide also explains the options available for the basic integration of the controller and its service processor into your network. There are MOSS-E worksheets for these options, which are to be filled out for the IBM service representative who does the actual controller installation or upgrade. The appendixes:

- Shows the panels of the MOSS-E service processor customization function
- Support offered by each level of the 3746 Licensed Internal Code.

ESCON Channels

After an overview of ESCON® and the adapters, the guide explains the configuration and tuning. This can be done with either the ESCON Generation Assistant (EGA) tool or the Controller Configuration Management (CCM) tool.

The guide also includes examples of various types of ESCON configurations.

Note: For information about using ESCON adapters on the MAE, refer to the *Multiaccess Enclosure Planning* guide.

Token Ring and Ethernet

Helps you with the configuration and definitions of your 3746 Network Node token-ring adapters (TRAs) for APPN/HPR-, IP-, and NCP-controlled traffic.

There are MOSS-E worksheets for the token-ring information needed by the IBM service representative to install or update your machine.

Although no longer available from IBM, the guide explains 3746 Ethernet support and Ethernet adapter configuration.

The token-ring (IEEE 802.5) and Ethernet (IEEE 802.3) standards are discussed in the appendixes.

Note: For Multiaccess Enclosure Ethernet information, refer to the *Multiaccess Enclosure Planning* guide.

Serial Line Adapters

Starts with an overview of the serial line adapters. Next X.25, frame-relay, PPP, and SDLC support are covered.

The two ways that the 3746 supports ISDN (LIC16 adapter[1] and terminal adapters) are explained, including how ISDN lines can be used as backups for other types of lines.

There is an appendix that gives the frame-relay support in each NCP level since frame relay was introduced in NCP Version 6.

Note: For Multiaccess Enclosure ISDN information, refer to the *Multiaccess Enclosure Planning* guide.

Physical Planning

Gives information to help you plan the physical site used by the 3745/3746s frames, service processor, and network node processor: the physical dimensions, electrical characteristics, and so on. It also gives this information for the various components of the 3745/3646, such as the Multiaccess Enclosure, Controller Extension, LICs, LCBs, ARCs, and so on.

The cable descriptions include feature codes (FCs) and part numbers used when ordering them.

[1] No longer being manufactured

The guide includes and explains the controller installation sheets, which show what IBM has installed on your machines.

Plugging sheets for keeping track of your installed LICs, ARCs, and cables are provided along with examples and explanations of their use.

Note: This type of information for the Multiaccess Enclosure is in the *Multiaccess Enclosure Planning* guide.

Management Planning

Starts with a management overview covering:

- Tivoli® NetView®
- Performance Management
- Service processor
- Network Node Processor
- APPN Topology Integrator

Then there are chapters about:

- APPN/HPR Network Node management
- NetView Performance Monitor
- Remote console support
- IBM Remote Support Facility
- 3746 IP router management
- Multiaccess Enclosure APPN/HPR Network Node management
- X.25 network

There are MOSS-E worksheets for the network management parameters needed by the IBM service representative to install or upgrade your machine.

The guide explains the use of the MOSS-E Service Processor Customization.

There is an example of ESCON management information base (MIB) definitions.

Note: For Multiaccess Enclosure management information, refer to the *Multiaccess Enclosure Planning* guide.

Multiaccess Enclosure Planning

Provides information about the Multiaccess Enclosure and its adapters (ATM, ESCON, and so on) and how to configure them.

For information about:

- Multiaccess Enclosure APPN/HPR Network Node management, refer to the *3745/3746 Planning Series: Management Planning*
- Physical site planning and the cables, refer to the *3745/3746 Planning Series: Physical Planning*

Protocols Description

Is an in depth description of these protocols used by the 3746:

- APPN/HPR
- IP

The detailed discussions of how the 3746 and Multiaccess Enclosure support these protocols help you understand the purpose of the protocol parameter definitions and what types of information are needed for the most efficient operation of your 3745/3746-connected networks.

CCM Planning Worksheets, (Online)

These example worksheets for the 3746 and MAE can be used to plan the actual definitions of the many CCM parameters you need to configure your 3746.

This guides is available (in PDF format) on the Web at

`http://www.ibm.com/networking/did/3746bks.html#Customer`

Who Should Use the 3745/3746 Planning Series

The *3745/3746 Planning Series* is intended for network planners, network specialists, and system programmers responsible for collecting the information required for the installation and network integration of 3745 Communication Controller Models A and 3746 Expansion Unit Model 900 in an SNA environment, as well as the 3746-950 and 3746-900 as APPN/HPR network nodes and IP routers.

Where to Find More Information

While planning a migration, you must use the following documents in addition to the *3745/3746 Planning Series* guides:

- IBM *3745 Communication Controller Models A and 170, 3746 Nways Multiprotocol Controller Models 900 and 950: Overview*, GA33-0180
- IBM *3745 Communication Controller All Models, 3746 Nways Multiprotocol Controller Model 900: Console Setup Guide*, SA33-0158 (This guide contains information about remote console access to 3745/3746-900s via an SNA/subarea, APPN, or TCP/IP path and using a modem.)

Also, you may need to use the following additional documents:

- IBM *3746 Nways Multiprotocol Controller Model 900 and 950: Controller Configuration and Management: User's Guide*, SH11-3081 (IBM recommends that you prepare controller definitions before installing a 3746. To obtain a stand-alone version of the Controller Configuration and Management that runs on an OS/2® workstation, contact your IBM marketing representative.)
- *3746 Nways Multiprotocol Controller Model 950: User's Guide*, SA33-0356. (This guide contains information about routine operations, installing and testing the communication line adapters, service processor, and remote consoles.)
- *Planning for Integrated Networks*.

Be sure to use the latest editions of these documents. This will ensure that you have up-to-date and complete information about the 3746 controllers.

The following *IBM International Technical Support Organization* redbooks provide useful information about 3746 implementation:

- *APPN Architecture and Product Implementations Tutorial*, GG24-3669
- *IBM 3746 Nways Multiprotocol Controller Model 950 and IBM Model 900: APPN Implementation Guide*, GG24-2536
- *Subarea Network to APPN Network Migration Guide*, SG24-4656
- *IBM 3746 Nways Multiprotocol Controller Model 950 and IBM Model 900: IP Implementation Guide*, SG24-4845 (an IBM redbook).

Be sure to see the other relevant documents listed in the bibliography at the back of this guide.

Additional Information on the Web

You can access the latest news and information about IBM network products, customer service and support, and information about microcode upgrades at:

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http://www.ibm.com/
```

The latest versions of the *Planning Series* and other 3745/3746 documentation are available in PDF format at:

```
http://www.ibm.com/networking/did/3746bks.html#Customer
```

CD-ROM

Starting with engineering change F12380, the Licensed Internal Code (LIC) is shipped on a CD-ROM. The complete 3745/3746 documentation set is also included on the CD-ROM.

Examples: 3745 Models A and 3746 *Planning Series*, 3746 NNP and Service Processor Installation and Maintenance Guides, CCM *User's Guide*, 3746-950 *User's Guide*, and others. See the bibliography for the complete name and form number of the books.

3745/3746 documentation is in PDF format. Acrobat Reader for OS/2® is included on the CD-ROM to allow you to read the .PDF files and print all or part of a book.

Accessing CD-ROM Information

To access the CD-ROM from a service processor equipped with a CD-ROM drive, do the following:

Step 1. Install the CD-ROM in the service processor CD-ROM drive.

Step 2. In the MOSS-E main panel, open the **View** menu and select **Information**.

Step 3. Double-click **CD-ROM documentation**. Your browser automatically opens and displays the documentation home page.

Step 4. Click any highlighted text (blue and underlined) to go to the material that interests you:

a. Click **Documentation** to access 3745/3746 books.

b. Click the icon marked PDF that corresponds to the item that interests you.

   The Acrobat Reader automatically opens and displays the file in the full panel mode. Use the **Page Up** and **Page Down** keys to move through the document.

   Press **Esc** to display the Reader menus that allow you to print all or part of the file.

   When you close the Acrobat Reader, you return to the browser.

   When you close the browser, you return to the MOSS-E Documentation menu.

Each document file has one or more of the following identifiers:

- Date
- Form number
- Engineering change level
- Revision code.

Check these identifiers on future releases of the CD-ROM to see if the documents that you use have been updated.

How to Use the 3745/3746 Planning Series

Your Responsibility as a Customer

You are responsible for performing the tasks listed in Table 1. These tasks are not performed by IBM personnel as part of the machine installation and basic operations. They can, however, be performed by IBM on a fee basis.

Table 1 (Page 1 of 3). Customer Tasks

Task	Where to Find Information
Network design:	Network design is not covered in this book. Refer to the following IBM books for SNA, APPN/HPR, and IP network planning guidance: • *Planning for Integrated Networks* • IBM redbooks: – *Subarea Network to APPN Network Migration Guide* – *IBM 3746 Nways Multiprotocol Controller Model 950 and IBM Model 900: APPN Implementation Guide* – *IBM 3746 Nways Multiprotocol Controller Model 950 and IBM Model 900: IP Implementation Guide* – *IBM Nways 2216 Multiaccess Connector Description* – *IBM 2216 Multiaccess Connector ESCON Solutions*
Physical planning: Before the IBM service representative arrives to install your controller, make sure that you have met the necessary requirements for the following: • Electric power • Floor space with service clearances • Space for the cables • The RSF switched line • The Controller Expansion (FC 5023) • Other components (such as the service processor).	“Physical Planning Details” chapter in the *3745/3746 Planning Series: Physical Planning*
Controller hardware configuration definitions: Decide what type of attachments (lines) and how many of each type you need.	This input is necessary for the IBM ordering system (CF3745). For more information, refer to the *3745/3746 Planning Series: Physical Planning*.

Table 1 (Page 2 of 3). Customer Tasks	
Task	**Where to Find Information**
Software definitions and tuning: • ESCON port, host link, and station definitions; ESCON resource, TCP/IP, and VTAM® tuning	Refer to: • "ESCON Adapters" chapter in the *3745/3746 Planning Series: ESCON Channels* • "ESCON Channel Adapter" chapter in the *3745/3746 Planning Series: Multiaccess Enclosure Planning* • "ESCON Configuration Examples" chapter in the *3745/3746 Planning Series: ESCON Channels*
• Token-ring port and station definitions; PU and LU maximum limits; port sharing with NCP-controlled traffic; duplicate addresses; token-ring APPN, IP, and/or NCP resource tuning and VTAM tuning	• "Token-Ring Adapters" chapter in the *3745/3746 Planning Series: Token Ring and Ethernet*
• Serial line (SDLC, PPP, frame-relay, and X.25) port and station definitions; location of CLPs, LICs, LCBs, and ARCs; maximum CLA line connectivity; CLP backups	• "Serial Line Adapters" chapter in the *3745/3746 Planning Series: Serial Line Adapters* • "3746 SDLC Support" chapter in the *3745/3746 Planning Series: Serial Line Adapters*
• Multiaccess Enclosure: hardware planning and configuration; software configuration and tuning	• *3745/3746 Planning Series: Multiaccess Enclosure Planning* • *3745/3746 Planning Series: Physical Planning*
• Use of the Controller Configuration and Management (CCM) application.	• *IBM Controller Configuration and Management User's Guide*, SH11-3081. Also refer to: • *IBM 3746 Nways Multiprotocol Controller Model 950 and IBM Model 900: APPN Implementation Guide* (an IBM redbook) • *IBM 3746 Nways Multiprotocol Controller Model 950 and IBM Model 900: IP Implementation Guide* (an IBM redbook).
Filling out: • 3746 plugging sheets To keep a record of the processors and couplers (and their addresses) installed in the 3746 frame.	Refer to: • "Plugging Sheets for 3745 and 3746" chapter in the *3745/3746 Planning Series: Physical Planning*
• *CCM User's Guide*, SH11-3081 worksheets To plan the 3746 and MAE logical resource definitions. They can then be used when configuring the 3746 and MAE via the CCM.	• *3745/3746 Planning Series: CCM Planning Worksheets*

Table 1 (Page 3 of 3). Customer Tasks	
Task	**Where to Find Information**
NetView definitions in VTAM, the MOSS-E, NPM, CCM, NetView/360, and Tivoli NetView® (formerly NetView for AIX) for: • APPN traffic • IP traffic • NetView alert path.	Refer to: • "3746 Management Overview" chapter in the *3745/3746 Planning Series: Management Planning* • "3746 APPN/HPR Network Node Management" chapter in the *3745/3746 Planning Series: Management Planning* • "3746 IP Router Management" chapter in the *3745/3746 Planning Series: Management Planning*.
Controller, service processor, and network node processor definitions. For example: • Link IPL port information • Password management • NetView alert reporting path definitions • DCAF LU definitions • Ethernet port definitions for SNMP • Service processor token-ring and IP LAN addresses.	Refer to "Controller and Service Processor Integration" chapter in the *3745/3746 Planning Series: Overview, Installation, and Integration*. Fill out the worksheets in the various *Planning Series* guides. These worksheets are used by the IBM service representative during installation.
Remote console definitions (using DCAF): • Ensure that the necessary hardware and software is available for the type of console attachment chosen • Service processor definitions for DCAF • DCAF installation and configuration on the remote console.	Refer to: • "Remote Customer Consoles" chapter in the *3745/3746 Planning Series: Management Planning* • For the 3746-900, refer to the *3745 Console Setup Guide* • For the 3746-950, refer to the *IBM 3746 Nways Multiprotocol Controller Model 950 User's Guide*
Connection to the IBM remote support facility (RSF): • Service processor connection (modem) definitions • Customer definitions for RSF records.	Refer to the "Connecting to the IBM Remote Support Facility" chapter in the *3745/3746 Planning Series: Management Planning*
Problem determination through the MOSS-E and NetView	For the 3746-900, refer to: • *Problem Analysis Guide* accessed online from the MOSS-E • *3745 Models A: Alert Reference Guide* • *3745 All Models: Advanced Operators Guide*

Finding Your Way Around in the New Planning Series

If you are familiar with the layout of the old *3745 Communication Controller Models A and 3746 Models 900 and 950: Planning Guide*, GA33-0457, Table 2 should help you find which of the eight new books of the planning series contains the information that you need.

Note: Some of the chapters in the *Planning Guide* have been split into two or more new chapters in one or more new guides.

Table 2 (Page 1 of 2). Location of Old Planning Guide Chapters in New Planning Guides

Old Planning Guide		New Planning Series Book	
Chapter	**Chapter Name**	**Chapters**	**Guide Name**
1	3745 and 3746 General Information	--	Not included in the new guides
2	APPN/HPR Overview	1	*Protocols Description*
3	Internet Protocol (IP) Overview	2	*Protocols Description*
4	3746 ATM Support	4	*Multiaccess Enclosure Planning*
5	Token-Ring/802.5	B	*Token-Ring and Ethernet*
6	Ethernet Overview	C	*Token-Ring and Ethernet*
7	Frame Relay Overview	4, 5	*Serial Line Adapters*
8	Point-to-Point Protocol (PPP) Overview	4	*Serial Line Adapters*
9	X.25 Overview	2, 3, 5, 7	*Serial Line Adapters* *Management Planning*
10	ISDN Adapters	8	*Serial Line Adapters*
11	ESCON Overview	1	*ESCON Channels*
12	3745 and 3746 Installation and Upgrade Scenarios	2	*Overview, Installation, and Integration*
13	Configuration Scenarios	6	*Multiaccess Enclosure Planning*
14	3746 Planning Overview	1	*Overview, Installation, and Integration*
15	ESCON Adapters	1, 2, 3	*ESCON Channels*
16	Token-Ring Adapters	1, 2, 3	*Token-Ring and Ethernet*
17	Ethernet Adapters	4, 5	*Token-Ring and Ethernet*
18	Serial Line Adapters	1	*Serial Line Adapters*
19	3746 SDLC Support	3, 4	*Serial Line Adapters*
20	Multiaccess Enclosure	1	*Multiaccess Enclosure Planning*
21	Multiaccess Enclosure Adapters Overview	2	*Multiaccess Enclosure Planning*
22	ESCON Channel Adapter	8	*Multiaccess Enclosure Planning*
23	Multiaccess Enclosure ISDN Support	5	*Multiaccess Enclosure Planning*
24	3746 Configuration Overview	--	Not included in the new guides
25	Welcome to the CCM	--	Not included in the new guides
26	Multiaccess Enclosure Configuration	7	*Multiaccess Enclosure Planning*
27	3746 Base Frame ESCON Configuration Examples	1	*ESCON Channels*
28	Configuring the MAE ESCON Channel Adapter	8	*Multiaccess Enclosure Planning*

Table 2 (Page 2 of 2). Location of Old Planning Guide Chapters in New Planning Guides			
Old Planning Guide		**New Planning Series Book**	
Chapter	**Chapter Name**	**Chapters**	**Guide Name**
29	3746 Management Overview	1	*Management Planning*
30	3746 APPN/HPR Network Node Management	2	*Management Planning*
31	3746 IP Router Management	6	*Management Planning*
32	MAE APPN/HPR Network Node Management	2	*Management Planning*
33	MAE IP Router Management	6	*Management Planning*
34	Controller and Service Processor	3	*Overview, Installation, and Integration*
35	Customer Consoles and DCAF	4 1 1	*Management Planning* *Overview, Installation, and Integration* *Token-Ring and Ethernet*
36	Connecting to the IBM Remote Support Facility	5	*Management Planning*
37	Performance Management with NetView Performance Monitor	3	*Management Planning*
37	3746 IP Router Management	6	*Management Planning*
38	MOSS-E Worksheets for Controller Installation (3745)	A A A	*Overview, Installation, and Integration* *Management Planning* *Token-Ring and Ethernet*
39	Parameter Cross-Reference Table	B	*Overview, Installation, and Integration*
40	CCM Worksheets for Controller Configuration Definitions	1	*CCM Planning Worksheets* (online)
41	Multiaccess Enclosure Worksheets	2	*CCM Planning Worksheets* (online)
42	Familiarizing Yourself with the Installation Sheets	2	*Physical Planning*
43	Plugging Sheets for the 3746 Nways Multiprotocol Controller	3	*Physical Planning*
44	Physical Planning Details	1	*Physical Planning*
A	3746-9x0 Microcode Levels (EC)	D	*Overview, Installation, and Integration*
B	ESCOM MIB	A	*Management Planning*
C	MOSS-E Service Processor Customization Function	C	*Overview, Installation, and Integration*

Chapter 1. Token-Ring Adapters

This chapter introduces you to the 3746 Network Node token-ring adapters (TRAs) for use with APPN®/High-Performance Routing (HPR), IP traffic, and Network Control Program (NCP).

Note: For details about the token-ring standard, see Appendix B, "Token-Ring (802.5) Standard" on page 33.

While waiting for delivery of your 3746 Network Node, start assembling the information necessary for its token-ring adapter definitions. To help with your token-ring planning, you can use the *CCM Planning Worksheets* available (in PDF format) at:

`http://www.ibm.com/networking/did/3746bks.html#Customer`

On the 3746, token-ring adapters (TRAs) consist of a token-ring processor (TRP), and token-ring interface couplers (TICs).

TRP Types

TRP Types include TRP, TRP2, and TRP3. Compared with the TRP (Type 1), the TRP2 has a 16-MB storage and the TRP3 has a 32-MB storage and a more powerful processor.

In this chapter, TRP stands for all TRP types, unless otherwise indicated. The improved performance and connectivity of TRP3 is described more specifically in "Token-Ring Adapter Connectivity" on page 4.

Planning for Token-Ring Adapters

The first step in planning your configuration is to decide how many TRAs you need. Besides physical connectivity, the following other items might affect the number of 3746 Network Node token-ring ports (TIC3s) and processors (TRPs) needed:

- How many active physical units (PUs) need to be connected (APPN/DLUS/DLUR/HPR and NCP)?
- How many user sessions need to be supported (APPN/DLUR, NCP)?
- What is the minimum number of TIC3s needed to satisfy your token-ring availability requirements (including backup TIC3s)?
- Are different types of traffic (3746 IP, 3746 APPN/HPR, and 3746 NCP) to be carried over the same TIC3 or over different TIC3s (and TRPs)?
- What is the expected data throughput or transaction rate?

Note: A maximum of 16 TRAs can be installed in the 3746 if there are no ESCAs or communication line adapters (CLAs) installed and if the second and third adapter enclosures are installed.

Use of Service Processor LAN

You must not attach any user stations to the service LAN of a 3746 Network Node. Refer to the "Controller and Service Processor Integration" chapter in the *3745/3746 Planning Series: Overview, Installation, and Integration*.

The service processor LAN must be used exclusively for communication between the service processor, CBSP[2], network node processor, Multiaccess Enclosure (MAE), and 3745 MOSS (for the 3746-900). The 3746 Network Node does not activate user stations over the TIC3 port connecting the service LAN (logical address 2080).

An NCP-controlled 3746-900 without NNP can run 500 PUs on the service processor LAN.

NCP Remote Loading and Activation in Twin-CCU Models

If you plan to use NCP remote loading and activation (RLA) operations with 3746-900 TIC3s while in twin-backup or twin-dual mode, you must use a different TIC3 for each CCU. Refer to the information on token-ring links in the *NCP V7 R2: Generation and Loading Guide*. To do RLA through TIC3 ports, the following resources have to be defined for each CCU:

- A physical line with an associated physical link station. There must be a different physical link for each CCU, that is, the NCP LOCADD keyword value (for the LINE definition) must be different for each CCU.
- A logical line with its associated logical link station in each CCU. There must be a different logical link for each CCU.

If the two CCUs access the same host via the same 3745 or 3746-900 TIC port, the corresponding PU definition has the same ADDR keyword value in both CCUs. This is shown in Figure 1 on page 3.

2 CBSP2 or CBSP3 is required if you are running APPN/HPR and/or IP traffic in the network node processor (NNP).

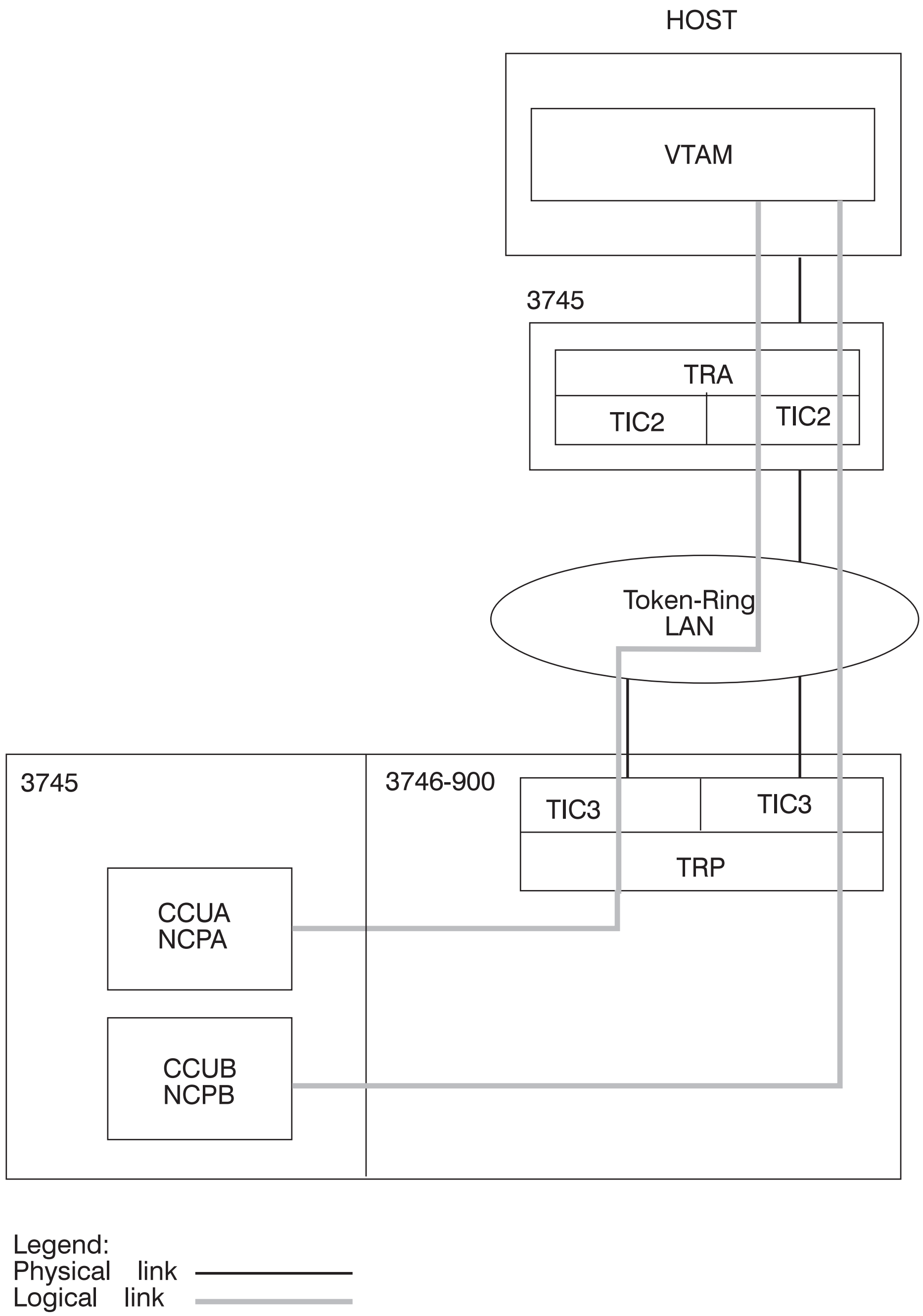


Figure 1. Physical and Logical Links

3746 Token-Ring Implementation

Token-Ring Adapter Connectivity

3746-900 with NCP Support

If your planning indicates that you can use your token-ring adapters near their maximum limits, you should consider having your system verified by the IBM 3745/3746 Configurator (CS3745).

The TRP3 can connect up to 4000 PUs simultaneously (for example, PS/2® workstations, or 3174s and downstream PUs). When two TIC3s are connected to the same TRP, any ratio of PU-sharing between the TIC3s can be used. For example, 3000 PUs can be active on one TIC3 while 1000 can be active via the other TIC3.

500 PUs can be active on the TIC3 of the CBSP, CBSP2, or CBSP3.

Up to 4000 PUs can be active on the TIC3 of the TRP3 connected to the CCU-B of the 3745[3].

The TIC3 can operate close to the token-ring media speed (16 Mbps), providing very high throughput between workstations and S/390 applications or S/390® databases and local servers.

3746 Network Node and 3746 IP Support

Connectivity of the TRP3 includes:

- Each TRP3 can connect up to 4000 active PUs (activated by NCP or NNP)
- Each TRP3 supports a maximum of up to 14 000[4] APPN/DLU sessions controlled by the 3746 NN.
- As connectivity examples, a TRP3 can support 2000 PUs along with about 7800 APPN/Dependent LU sessions controlled by the 3746 NN, or 100 PUs along with about 13 500 such sessions. These examples assume that the IP routing option is not present in any TRA.
- Each TRP3 supports any number of ANR sessions over HPR connections between HPR/RTP edge nodes, and can connect any number of IP stations.
- The TRP3 can concurrently carry traffic controlled by the 3746 NN, the 3746 IP router and, for the 3746-900, one or two NCPs.
- Each TIC3 can carry traffic for the 3746 Network Node (APPN/DLUR/HPR), the 3746 IP router, and one NCP (3746-900).

[3] For 3745 Models 41A and 61A, a TIC slot is used by the controller bus coupler (CBC) to connect to the second CCU.

[4] Not all the maximum connection capabilities may be possible. For a given processor, the maximum number of resources in a category (3746-controlled PUs, NCP-controlled PUs, 3746-controlled sessions, SDLC links) depends on the number of active resources in other categories, the presence of the IP routing feature, and, in the CLP, the mix of lines (SDLC, frame relay, X.25).

For example, TRP2s (without IP routing) can support simultaneously a total of 500 APPN/HPR PUs and about 3000 data sessions.

Connectivity of the TRP2 includes the following capabilities:

- Each TRP2 can connect up to 2000 PUs activated by NCP, or about 1400[4] PUs activated by the 3746 NN, or a mix of both.
- Each TRP2 of a 3746-950 can activate about 1400[4] PUs.
- Each TRP2 supports a maximum of up to 4700[4] APPN/DLU sessions controlled by the 3746 NN.
- As an example, a TRP2 can support 500 PUs (APPN/HPR nodes and (or) dependent PUs), with a total of about 3000 APPN/DLU sessions activated by the 3746 NN.
- Each TRP2 supports any number of ANR sessions over HPR connections between HPR/RTP edge nodes, and can connect any number of IP stations.
- The TRP2 can concurrently carry traffic controlled by the 3746 NN, the 3746 IP router and one or two NCPs. Each TIC3 can carry traffic for the 3746 Network Node (APPN/DLUR/HPR), the 3746 IP router, and one NCP.

Note: A token-ring LAN that attaches PUs controlled by NCP in CCU-A and PUs controlled by NCP in CCU-B requires two TIC3 ports.

Checking of Activation Limits and Capacity Planning

Activation limits are controlled in the following ways:

3745/3746 configurator (CF3745) for planning TRP storage and PU limits.

The performance and storage model of CF3745 can be used to verify that the planned TRP configurations do not exceed the storage and PU limits of the TRP.

NetView® Performance Monitor (NPM) for TRP storage and processor utilization.

NPM Version 2, Release 4 with PTF monitors the storage, processor utilizations of TRPs, and number of active PUs per TIC3.

Note: For older NPM Versions, refer to the *3745 Communication Controller Models A and 170, 3746 Nways Multiprotocol Controller Models 900 and 950: Overview*, GA33-0180 to see the necessary updates necessary for this function.

This information can be used to balance PUs between existing TRPs or help in adding new TRPs.

MOSS-E function for TRP storage and processor utilization.

The Performance Management function of the MOSS-E can produce a graph of TRP storage and processor utilization. This information can be used to balance PUs between existing TRPs or help in adding new TRPs.

CCM function

The Controller Configuration and Management program can display the total number of active PUs, active SSCP-PU sessions, active SSCP-LU sessions, and LU-LU sessions. This total includes the sessions flowing over token-ring lines.

This information can be used to balance PUs between existing TRPs or help in adding new TRPs.

PU limit per TRP

If a TRP has reached its limit of active PUs and:

- If the 3746 control point or 3746-900 NCP tries to activate another PU, the TRP rejects the PU activation and a generic alert is sent to NetView indicating a congestion status.
- If there is an incoming call from a workstation, the TRP ignores the activation request (TEST frame).

Storage limit for TRP storage thresholds.

TRP at high-storage threshold (97%)
When the TRP storage utilization is greater than or equal to 97% over a period of three minutes, an alarm and a NetView alert are generated (every three minutes, up to three times).

TRP back to normal storage threshold (95%)
An alarm and a NetView alert are generated when both the following are true about TRP storage utilization:

- It is greater than or equal to 97% over a period of three minutes or more *and*
- It decreases to 95% or less over a period of three minutes.

If the storage limit of the TRP is reached:

- New PU activation requests from the 3746 control point (for example, from the Management Menu of CCM) or an NCP (3746-900) and new LU-LU activation requests are rejected and a message is returned to the requester indicating a congestion status.
- New incoming calls (TEST frames) from workstations are ignored by the TRP.

Note: There is no automatic control of the number of LU sessions being established by the 3746 control point for a given TRP.

Incoming Calls

Incoming calls over a TIC3 port are accepted by the 3746 Network Node in two cases:

- The calling station is predefined in the 3746 Network Node.
- The TIC3 port is defined with the CCM **Accept Incoming Calls** parameter set.

Unshielded Twisted-Pair Cabling

An IBM 8250 Multiprotocol Intelligent Hub, with a token-ring Multistation Access Unit (MAU) Module, can be connected to a TIC3 using an Unshielded Twisted-Pair (UTP) cable and a token-ring UTP Media Filter. The filter, which must be plugged into the TIC3, and the UTP cable replace the token-ring attachment cable.

The UTP media filter is a component of the IBM 8250. Depending on the country, it must be ordered as either an accessory (part number 43G3875) or a feature (number 3875). For more information on the UTP media filter and cables, refer to the “Physical Planning Details” chapter in the *3745/3746 Planning Series: Multiaccess Enclosure Planning*, GA27-4240.

Token-Ring Port Sharing with NCP (3746-900)

The 3746 Network Node and NCP can share the same TIC3 port, but this may lead to problems when one of the limits of active PUs is reached.

Note: When there is a TIC3 shared between NCP and the 3746 Network Node and the NCP or TRP reaches the maximum number of possible active PUs, ***call-ins will not be accepted*** for NCP or for the Network Node CP (3746 Network Node control point).

Note: The maximum number of active PUs is reached if one of the following conditions occurs:

For NCP

- There are no more stations available in the pool of token-ring switched stations.
- No CCU storage remains available for PU activation.

For a TRP

- 2000 (TRP2) or 4000 (TRP3) active PU limit reached
- No TRP storage remains available for PU activation.

When a port is shared between NCP-control and a 3746 NNP-control, the definitions for the port in NCP and CCM must use the following information:

- Same local MAC address
- Same speed
- Different local SAPs ('04' is the SAP used by NCP).

Otherwise, the second activation of the port is refused.

Token-Ring Availability Functions

Duplicate TIC3 Addressing (3746 Network Node and NCP)

Duplicate TIC addresses can be used to provide automatic backup and load distribution for APPN, HPR, and ACF/VTAM® software-dependent (DLUR) traffic controlled by the 3746 Network Node (NN) or NCP.

As shown in Figure 2, a duplicate address configuration consists of multiple TIC3s, sharing the following characteristics:

- Installed in the same 3746
- Using the same MAC address (the locally administered address)
- Connected to the LAN backbone via bridges.

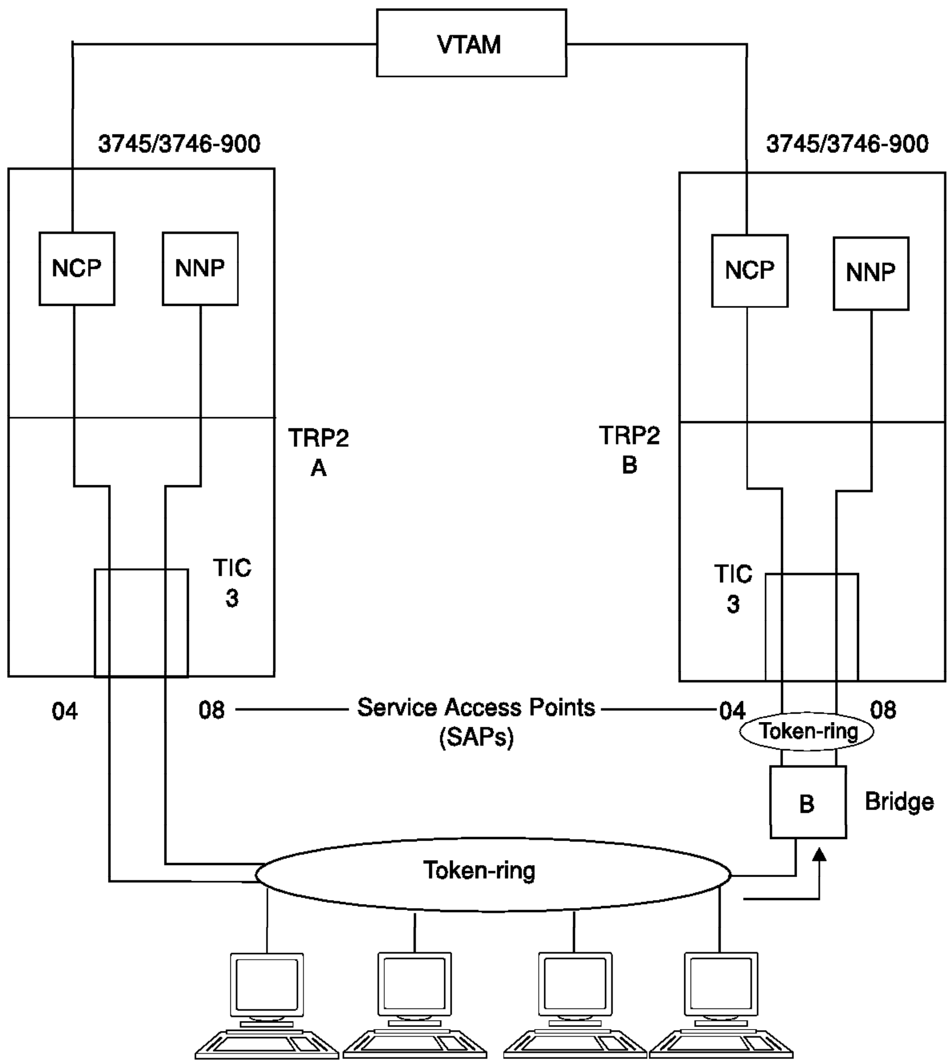


Figure 2. Example Configuration Using Duplicate TIC3 Addresses

To connect NCP-controlled PUs and NNP-controlled PUs, each TIC3 (using the same duplicate MAC address) must be enabled with the same set of service access point (SAP) values: one SAP for NCP (default = 4) and one SAP for the NNP.

When TIC3s are used in this type of TIC address configuration, they operate as follows:

- For an incoming call, the PU is activated and the LU-LU session is established via the first TIC3 port that answers the workstation request (TEST frame).

  If the maximum number of allowed active PUs has been reached on a TRP, or if either NCP or the APPN control point are congested, the TRP ignores the workstation request (there is no NetView alert). If there is a TIC3 with the same MAC address, and it is connected to another TRP (as shown in Figure 2 on page 8) that has not reached its PU limit, then the PU is activated and the LU-LU session is established via this second TRP.

- For outgoing calls (PU activation requests from VTAM® from CCM), the 3746 control point is able to distribute them over the TIC3 ports with the same MAC address, provided that these ports are on the same 3746 Network Node.

If, for any reason, the traffic through a given path is interrupted, this procedure reconnects the PUs via the remaining TIC3s. An alert is sent to NetView, and the traffic will automatically begin to flow again via another path.

Note: If you want to use duplicate TIC addresses in a 3746-900 configuration, you must *not* use the same set of TIC3s to connect NCP-controlled PUs and 3746-controlled PUs.

If you use the same set of TIC3s, the TRP responds to all the test frames, even if one of the control points (NCP or NNP) is no longer able to accept new incoming calls. This would prevent the test frames from being answered by the alternate NCP or 3746 NNP, and the user from being (re)connected via this NCP or 3746 NNP.

TIC Port Swapping (NCP Control Only)

TIC port swapping can be used if there is a token-ring adapter (TRA) problem in either the TIC3 or the TRP. When using TIC port swapping, the following rules must be taken into consideration:

- TIC port swapping must use TICs of the same type (a TIC2-TIC3 swap is not possible).
- You cannot port swap between the TIC3 of the CBSP and any other TIC3.

Token-Ring Non-Disruptive Route Switching (NCP Control Only)

This function can bypass token-ring network problems affecting the communication between a TIC2 or TIC3 on one 3745/3746-900 and a TIC on another 3745 if the 3745/3746-900s are inter-connected via token-ring LANs and bridges with at least two different paths.

If the communication with another 3745 (or 3745/3746-900) node is lost, the 3745/3746-900 attempts to reestablish the logical connection before the link is made inoperative. If an alternate route is available using the same TICs and the other 3745/3746-900 is still active on the token-ring LAN, then normal NCP-to-NCP communication continues. The following TICs can be used:

- Two TIC2s
- Two TIC3s
- A TIC Type 2 and 3.

Mixed-Media Multilink Transmission Groups (NCP Control Only)

Mixed-media MLTGs consisting of multiple token-ring LAN connections between two 3745s or 3745/3746-900s can provide a non-disruptive backup path and load balancing for the subarea traffic between the two NCPs. TIC Types 2 and 3 can be in the same mixed-media MLTG.

Migrating a Duplicate TIC3 Address Configuration from NCP to 3746 Network Node

The scenario described in this section allows you to migrate your token-ring lines from NCP control to 3746 Network Node control (APPN, DLUR, and/or HPR) with the following objectives:

- No changes in token-ring-attached devices
- No changes in applications
- Limited changes in the 3746-900
- 100% backup capability during the whole migration.

Figure 3 shows the scenario before (1 - line under NCP control) and after (2 - line under 3746 NNP control) the migration.

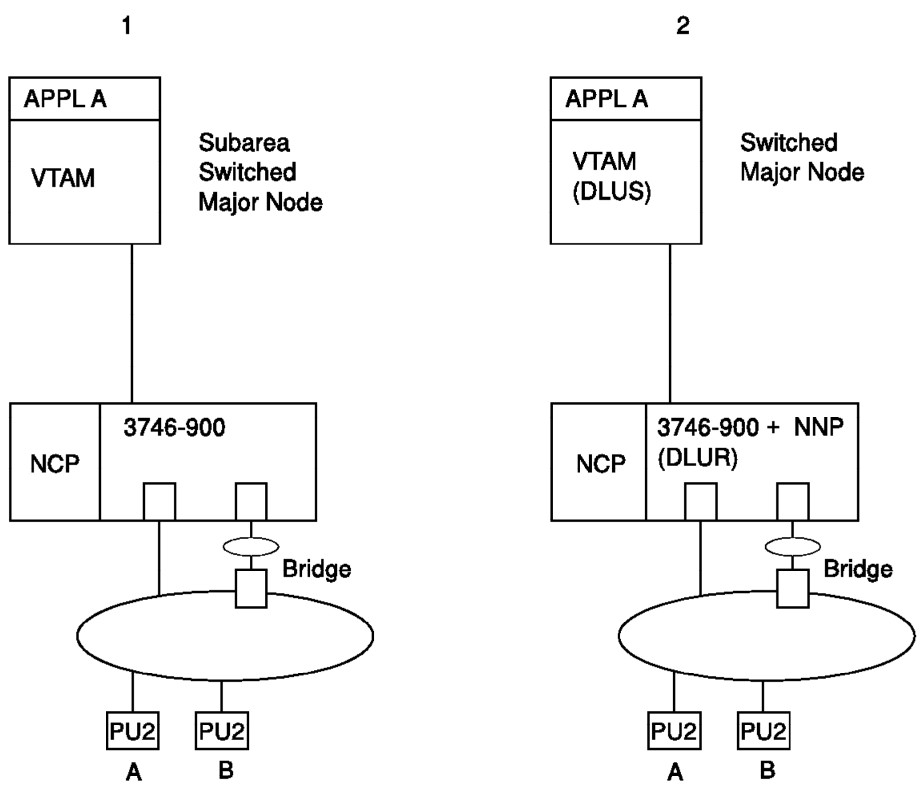


Figure 3. Migrating Duplicate TIC3 Address Configuration from NCP to 3746-Network Node

Notes:

1. For VTAM changes refer to the "APPN / HPR Overview" chapter in the *3745/3746 Planning Series: Protocols Description*, GA27-4241 and "VTAM DLCADDR Keyword for Token-Ring LANs" on page 13.
2. The network node processor must be installed and operational before starting the migration procedure.

Migration Procedure

Follow these steps to migrate your duplicate TIC3s:

Step 1. Set up the DLUS function (VTAM Version 4 Release 4 is recommended, though VTAM V4R2 is the minimum level required).

Step 2. Prepare a CCM configuration with the same MAC address for your two TIC3s (as defined in the NCP), and configure them with SAP=04. This is the SAP used by NCP token-ring implementation and you must define the CCM configuration with the same SAP=04 to avoid remote device changes.

Step 3. Deactivate one NCP token-ring line (TIC3), then load and activate the new CCM configuration for this TIC3.

Note: *Do not* activate the TIC3 corresponding to the line still active in NCP.

You can now start handling your PU2s through two TIC3s with the same MAC address:

- One TIC3 controlled by NCP
- One TIC3 controlled by the NNP.

When your stations (remote PU2s) try to connect, they connect randomly to one TIC3 or the other (the first TIC3 that answers the TEST frame is used for the connection).

Step 4. Using the Management menu of CCM, verify that your 3746 Network Node (DLUR) configuration is working. After verifying that some PU2s are connected under NNP control, deactivate the second NCP TIC3 and re-activate it under NNP control.

Step 5. You now have two TIC3s under NNP control, with the same SAP and MAC addresses previously used with NCP, handling your PUs through DLUR.

Step 6. If there are problems, deactivate the two TIC3 ports in the Management menu of CCM and reactivate them in NCP.

Notes:

1. Using the local CCM, you must inactivate the NCP line (SAP=04) ***before*** you activate this TIC3 (that has the same SAP) under NNP control. If you try to activate the TIC3 line under NNP control when one or more NCP PUs are already active on this line, you will receive a sense code and your activation will be rejected.
2. For information related to token-ring DLUR/DLUS, refer to the “APPN / HPR Overview” chapter in the *3745/3746 Planning Series: Protocols Description*.
3. Only minor changes need to be made to your switched major node in VTAM. Also refer to the “APPN / HPR Overview” chapter in the *3745/3746 Planning Series: Protocols Description*.

Chapter 2. Token-Ring Configuration

This chapter is designed to help you with the configuration and definitions of your 3746 Network Node token-ring adapters (TRAs) for APPN/HPR, IP traffic, and NCP.

Controller Configuration and Management (CCM) is used to configure token-ring resources. To plan these resources you can use the *3745/3746 Planning Series: CCM Planning Worksheets* located on the Internet at:

`http://www.ibm.com/networking/did/3746bks.htm#Customer`

NCP Definitions for TIC3s in Twin-CCU Models

In twin-CCU machines, any token-ring port (TIC3) can be activated by the NCP in either CCU. After deactivation by an NCP, the other NCP can activate it. The TIC3 cannot be activated by both CCUs at the same time.

When used to carry intermediate network node (INN) traffic with another 3745 or 3745/3746-900, a TIC3 port is configured in the NCP with the following resources:

- A physical link (and its associated physical link station) that represents the TIC3 port. In the LINE definition statement for the physical link, the LOCADD keyword value represents the MAC address of the TIC3 port.

  A physical link cannot be shared by both CCUs.

- A logical link (and its associated logical link station) that represents a connection between one of the two CCUs and a VTAM.

  In the NCP PU definition statement for the logical link station, the ADDR parameter value defines the MAC address of the TIC port on the other 3745 or 3745/3746-900.

See Figure 1 on page 3.

VTAM DLCADDR Keyword for Token-Ring LANs

Refer to the “APPN / HPR Overview” chapter in the *3745/3746 Planning Series: Protocols Description* for a list of possible VTAM DLCADDR keyword coding formats. A token-ring data link control (DLC) address for an SNA peripheral resource has these elements:

- DLC type
- Port name
- Destination service access point (DSAP)
- Destination MAC address.

The token-ring DLCADDR is coded as follows:

1. Specify a token-ring DLC type:

   `DLCADDR=(1,C,TR),`

2. Identify the port name of the token-ring physical line:

   `DLCADDR=(2,I,`*port_name*`),` where *port_name* is the name of the port specified in *CCM User's Guide*, SH11-3081.

3. Specify the DSAP:

   `DLCADDR=(3,X,`*hh*`)`, where *hh* is the SAP of the remote token-ring device, in hexadecimal.

4. Specify the token-ring destination MAC address:

   `DLCADDR=(4,X,`*hhhhhhhhhhhh*`)` where *hhhhhhhhhhhh* is the destination MAC address of the peripheral device on the token-ring LAN.

Example VTAM Switched Major Nodes

For Token-Ring Lines

It is not necessary to change the switched major node definitions that you are currently using for your token-ring lines when setting up your DLUS/DLUR pipes.

Token-Ring switched major node for call-in example:

```
*******************************************************************
*
*  TOKEN RING       BNN STATION   CALL-IN
*
*******************************************************************
ZITPNS07 VBUILD TYPE=SWNET
*-----------------------------------------------------------------*
* TERMINAL Q7881001/Q7882001/Q7883001
*-----------------------------------------------------------------*
N7881001 PU    ADDR=04,PUTYPE=2,IDBLK=03A,IDNUM=A5000,          X
               MAXPATH=8,MAXDATA=4000,MAXOUT=7,DISCNT=NO,        X
               ISTATUS=INACTIVE,ANS=CONT
Q7881001 LU    LOCADDR=02,PACING=5,VPACING=6,MODETAB=LANMOTAB
Q7882001 LU    LOCADDR=03,PACING=5,VPACING=6,MODETAB=LANMOTAB
Q7883001 LU    LOCADDR=04,PACING=5,VPACING=6,MODETAB=LANMOTAB
*-----------------------------------------------------------------*
```

Token-Ring switched major node for call-out example:

```
*****************************************************************
*
*  TOKEN RING       BNN STATION   CALL-OUT
*
*****************************************************************
ZOTPNS71 VBUILD TYPE=SWNET,MAXGRP=1,MAXNO=125,MAXDLUR=1
*---------------------------------------------------------------------*
* TERMINAL Q7881001 ---> Q7883001
*---------------------------------------------------------------------*
N7881001 PU    ADDR=04,PUTYPE=2,IDBLK=03A,IDNUM=A5000,            X
               MAXPATH=8,MAXDATA=4000,MAXOUT=7,DISCNT=YES,          X
               ISTATUS=INACTIVE,ANS=CONT,DWACT=YES
P7881001 PATH  PID=1,DLURNAME=ERS1,                                  X
               DLCADDR=(1,C,TR),                                       X
               DLCADDR=(2,X,54494332313736), * Portname on CCM * (#1)X
               DLCADDR=(3,D,04),             * DSAP = 04 *           X
               DLCADDR=(4,X,400000071088)    * Remote MAC address *
Q7881001 LU    LOCADDR=02,PACING=5,VPACING=6
Q7882001 LU    LOCADDR=03,PACING=5,VPACING=6
Q7883001 LU    LOCADDR=04,PACING=5,VPACING=6
*---------------------------------------------------------------------*
Note : (#1) Port Name specified in CCM = TIC2176  (ASCII characters)
            converted to hexadecimal in DLCADDR parameter.
```

Note: If you want to use ASCII format for DLCADDR, refer to the “APPN / HPR Overview” chapter in the *3745/3746 Planning Series: Protocols Description*. Then this line:

```
DLCADDR=(2,X,54494332313736), * Portname on CCM * (#1)
```

would be coded as:

```
DLCADDR=(2,I,TIC2176), * Portname on CCM * (#1)
```

Token-Ring Load Balancing

BNN support for duplicate TIC addressing (for both TIC2s and TIC3s) was introduced to provide backup capability for TICs in the event of a LAN component failure. In addition, it allows down-stream PUs (DSPUs) to connect to any TIC with the same MAC address. (There must be a connection from NCP to the VTAM in which the BNN station is defined.) Ideally, this results in statistical load balancing by spreading LAN traffic across the multiple duplicate TICs.

However, unequal distribution occurs for incoming calls when the majority of the connections are established through one particular TIC in a group of TICs that use the same MAC address. This disparity is the result of both the nature of a bridged token-ring environment and the DSPU. When a BNN station wants to connect to a specific MAC address, it broadcasts a route discovery frame (“Test Resolve” or “XID802.2” command frame) to determine a path through the LAN network to any TIC having the MAC address. Because duplicate TICs supporting BNN connections are isolated on apex rings that are attached by bridges to a backbone ring, one bridge will always forward the discovery frame to its associated apex ring before the other bridges. This can result in the TIC, isolated on that apex ring, receiving the discovery frame sooner than the other TICs and, thus, enabling it to respond first. Because DSPUs generally use the path indicated in the first response received, most (if not all) of the connections are established through this first TIC, resulting in potential load problems once session data begins to flow.

A balancing mechanism that results in better IEEE 802.2 LLC peripheral connection distribution for DSPUs, resulting in the traffic load being more evenly supported across the duplicate TICs, has been implemented. This call or connection balancing mechanism is similar to that supported by the IBM 3172 Interconnect Controller.

This enhanced load balancing counts the number of token-ring logical, peripheral connections that are established through a TIC. Based on the number of supported connections, the TIC increases the time needed for additional peripheral connections by delaying its response to the route discovery frames. This delay allows the incoming call requests to be established through an alternate duplicate TIC, thus resulting in a better call distribution.

Time Delay and Working Count

The amount of time (in seconds) that a response is delayed is determined using the following expression:

```
Time_Delay = ((Number_Of_Sessions/(Connection_Balance_Factor * 16)) * 0.1
```

The expression calculates the number of 100-ms time-periods that must pass before a response can be sent. Because the T1 timer default is 1.0 seconds, the time delay value is restricted to a 0.9 second maximum. This prevents a broadcast storm of retransmitted route discovery frames. To further ensure that a broadcast storm does not occur, all responses for peripheral route discovery frames are given the highest transmission priority; any time a response is transmitted, it is sent ahead of any queued frames awaiting transmission.

Each peripheral connection generated for either an incoming or outgoing call request are counted. This working count is decreased when a peripheral connection is brought down.

Connection Balancing Factor

The connection balancing factor is a user-defined value that controls the granularity of the connection balancing. The balancing factor value has a range from 0 to 16.

A zero value means that the TIC will not perform the connection balancing function, the TIC will respond immediately to all route discovery frames.

A balancing factor of:

1 gives a 16 connection granularity.

According to the Time_Delay expression, while there are less than 16 peripheral connections established over the TIC, no response time delay is introduced.

Once 16 peripheral connections have been established, there is a 100 millisecond delay before sending a response to route discovery frames. This allows the other duplicate TICs fewer connections to accept the incoming call requests. This delay increases to 200 milliseconds once 32 connections have been established and so on.

16 gives a 256 connection granularity.

While there are less than 256 peripheral connections established over the TIC, no response time delay is introduced. After 256 connections are established, there is a 100 millisecond delay. After 512 connections, there is a 200 millisecond delay and so on.

For a duplicate TIC environment supporting a small number of DSPUs (200), a finer balancing granularity (smaller balancing factor) would be appropriate. Conversely, a larger balancing factor would be suitable for an environment supporting a larger number of DSPUs (2500). The following expression can be used to suggest an adequate balancing factor based on the total number of DSPUs to be supported by the duplicate TIC environment:

```
Balancing_Factor = Max(1,Min(16,Int(Total_Number_of_DSPUs/160)))
```

Because the connection balancing function is performed independently by the duplicate TICs, there is no limit to the number of TICs that may participate in this balancing scheme. To achieve an approximately symmetrical connection distribution, it is recommended that the same connection balancing factor be defined for all of the duplicate MAC addresses. However, defining differing values can result in a weighted connection distribution, which may be more suitable for your network configuration.

NCP NDF Keyword

The keyword BALANCE is coded in the physical GROUP and LINE definition statements in one of the following ways:

BALANCE=(*factor*,H)
BALANCE=(*factor*,D)
BALANCE=(AUTO).

Where *factor* is an integer or the character string AUTO.

H means that BALANCE is coded in hexadecimal, D means that BALANCE is coded in decimal. The decimal format is the default format if H or D is not specified. This keyword has the following possible values:

- 0 for no load balancing, the default value
- 1 to 16 for manually defining the balance factor
- 'AUTO' to call the auto-adaptive load balancing explained in "Automatic Load Balancing Configuration" on page 19.

APPN CCM Configuration

The Connection Balance Factor can be defined in the **Token-Ring Port - Default Parameters** panel (for DLC parameters) for all traffic on the TIC3. The value of this parameter has a range of:

- No Load Balancing, the default value
- 1 to 16 for manually defining the balance factor
- Automatic to call the auto-adaptive load balancing explained in "Automatic Load Balancing Configuration" on page 19.

Note: Load balancing is not applicable to IP traffic because IP is connectionless and does not exchange Test or XID frames.

Load Balancing and Multi-Link Sharing

On token-ring links that are shared between NCP and APPN, if load balancing is defined in either NCP or APPN, it is applied to the TIC.

If load balancing is defined for both NCP and APPN, the connection balance factor with the highest value is used. Auto-adaptive load balancing is the highest possible value.

Manual Load Balancing Configuration

The manually configured Connection Balance Factor defines the slope of the straight line in Figure 4. This factor is set follow the maximum number of stations but is not dynamically adjusted to follow the changing number of simultaneous active stations.

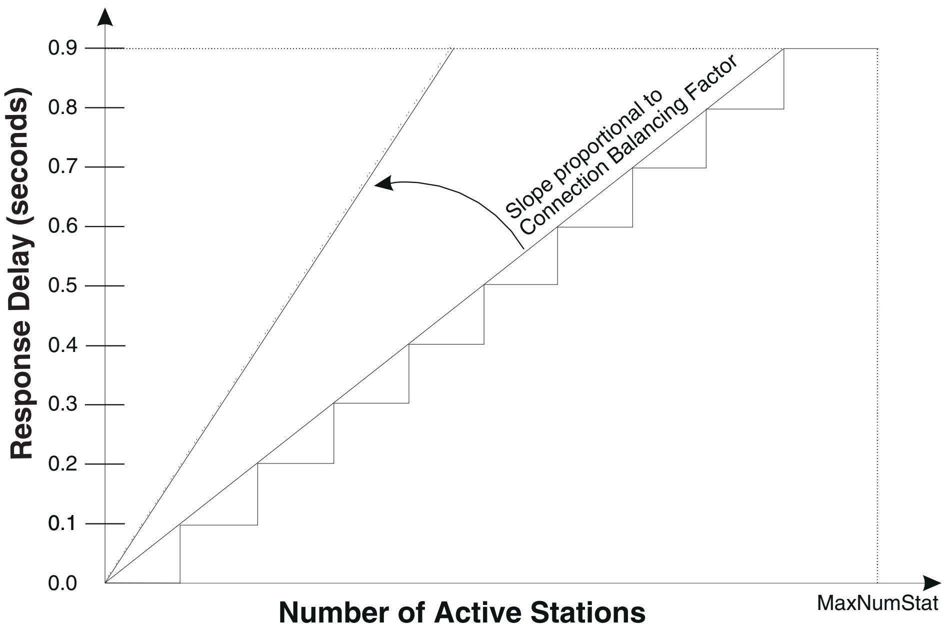


Figure 4. Straight Line Slope with Manual Configuration

Automatic Load Balancing Configuration

The auto-adaptive balance function is an improvement over manually configured load balancing. Auto-adaptive load balancing tries to keep a constant ratio between the weight of a new station and the number of already active stations. The slope in Figure 5 is a logarithmic curve defined by:

`f(`*x*`) = Ln(`*x*` + 1) / Ln(MaxNumStat + 1)` where:

- *x* = number of active station
- f(*x*) = delay (seconds) before responding to test frame.

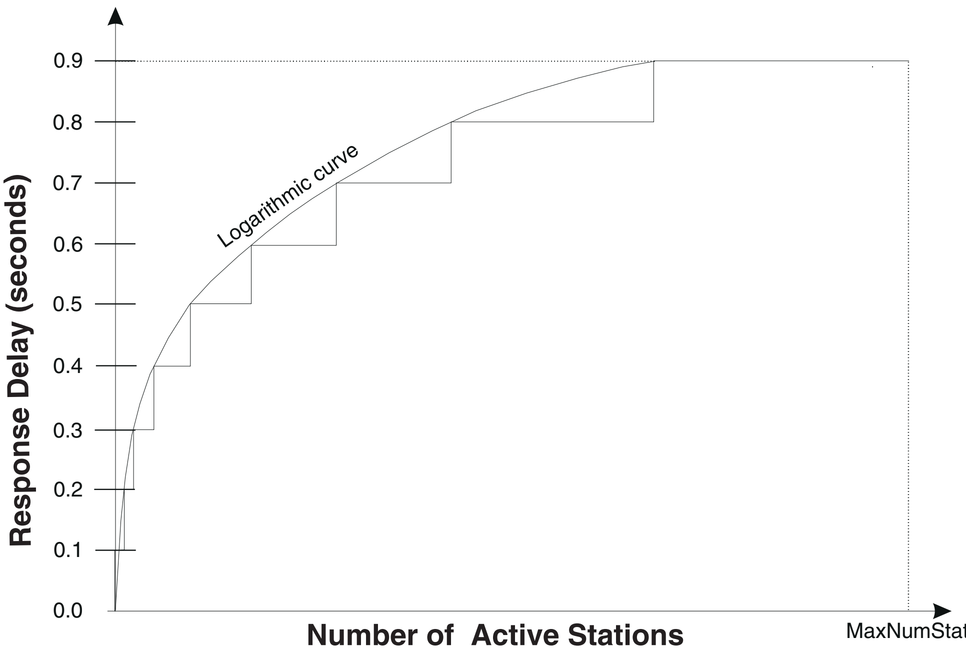


Figure 5. Logarithmic Slope with Auto-Adaptive Balancing Configuration

As MaxNumStat increases, the weight of each new station decreases.

The load balancing is constantly adjusted with the number of currently active stations.

Automatic Load Balancing Configuration Example

Table 3 shows the length (in seconds) of delay in response to a test frame as a function of the number of active stations using:

```
x = Int(e(y * Ln(MaxNumStat + 1)) -1)
```

where

```
y = Int(Ln(x + 1) / Ln(MaxNumStat + 1))
```

Table 3. Response Delays when MaxNumStat equals 4000

Number of Active Stations	Response Delay (seconds)
0 ≤ x < 1	0.0
1 ≤ x < 4	0.1
4 ≤ x < 10	0.2
10 ≤ x < 24	0.3
24 ≤ x < 54	0.4
54 ≤ x < 121	0.5
121 ≤ x < 271	0.6
271 ≤ x < 604	0.7
604 ≤ x < 1346	0.8
1346 ≤ x < 4000	0.9

Hardware Requirements

Manual load balancing can use either:

- TIC2s (in a 3745)
- TIC3s connected to TRP3s (in a 3746-9X0)
- Or both: token-ring lines on the 3745 and 3746-900 can be manually configured to use delayed response-time load balancing at the same time.

Automatic load balancing, using a delayed response time, uses only TIC3s connected to TRP3s in a 3746-9X0.

Token-Ring Dynamic Windowing

The dynamic windowing feature allows the user to progressively increase or decrease the working window (Ww) of an 802.2 station in the case of congestion or frame loss. (The Ww is the current number of I-frames that can be sent to an adjacent link station before an acknowledgement must be received.)

To extend the dynamic windowing inside the TRP, NCP adds support for the second and third parameters (*dw* and *dwc*) of the DYNWIND keyword for token-ring outboard data link control (ODLC) resources. CCM also adds the support of the new parameters *dw* and *dwc* for the defined APPN token-ring station. The *dw* parameter specifies how much to reduce a link station's working window when frame loss is detected. The *dwc* parameter specifies how much to reduce the working window when network congestion occurs.

Note: The *dw* and *dwc* parameters follow the same rules as the *dw* and *dwc* parameters that are defined for frame relay.

dw Parameter

In earlier releases, the token-ring DLC reset Ww to 1 when frame loss was detected on bridged connections. (The frame loss could be caused by a hardware problem in the network or by network congestion.) The new *dw* support allows a less severe reduction of Ww, thus providing quicker recovery from network problems. The default value for *dw* is 1.

This function is equally effective for networks that utilize transparent bridges. The token-ring DLC reduces Ww by the value of *dw*, or sets Ww to 1 when the user does not code *dw*, even when the connection does not appear to DLC as bridged (that is, routing information does not exist).

dwc Parameter

The *dwc* parameter is used specifically when congestion occurs. For frame-relay networks, congestion is indicated when a frame is received that has the backward explicit congestion notification (BECN) indicator on. For token-ring networks, there is no specific indicator of congestion (other than frame loss). However, when the DLC receives a receive not ready (RNR), it sets a Remote Station Busy state and will not send frames to the station until a receive ready (RR) is received from the station. If the station does not respond with an RR within the time limit specified by the RNRLIMT keyword, the DLC reports the station as inoperative, and the connection is terminated.

In earlier releases, the token-ring DLC made no change to Ww as a result of receiving the RNR. The *dwc* parameter reduces Ww to the value coded on *dwc* when the DLC sets a Remote Station Busy State. This permits a more effective use of the network by allowing Ww to decrease to a more currently suitable value.

The enhancement to support *dwc* is particularly important in configurations that involve the combination of token-ring and frame-relay networks. Figure 6 illustrates a variety of connections involving token-ring and frame-relay networks.

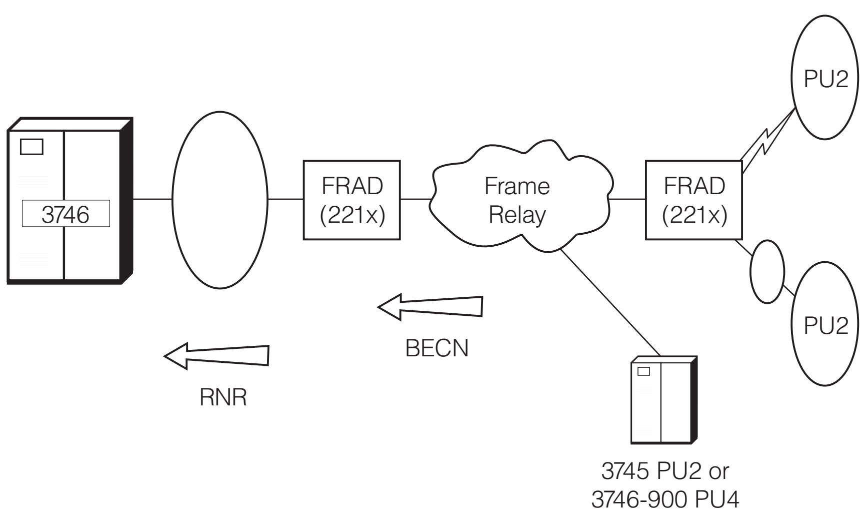


Figure 6. Example of a Hybrid Network Configuration

Technologies such as boundary access node (BAN) and data link switching (DLSw) are used to transport frames across the hybrid network. When network congestion occurs, the frame-relay access device (FRAD) receives a frame with the BECN indicator on. The FRAD reacts by sending an RNR over its token-ring interface. In addition to suspending transmission to the station, NCP reacts to the RNR by reducing Ww to the value coded for *dwc*. If the user has not coded a value for *dwc*, no Ww reduction takes place, but the DLC still suspends transmission to the station.

Chapter 3. Token-Ring Tuning

This chapter is designed to help you tune the configuration and definitions of your 3746 Network Node token-ring adapters (TRAs) for APPN/HPR, IP traffic, and NCP.

Maximum BTU Size (APPN/DLUR and HPR)

The maximum Basic Transmission Unit (BTU) size supported by the 3746 Network Node is 8000 bytes. For token-ring links, the CCM parameters maximum received PIU size and maximum sent PIU size in the Port Configuration - APPN Configuration panel of the CCM should be set to 8000 bytes if possible.

The value of the send and receive PIUs (BTU size) that you choose must be a compromise:

- The maximum value of 8000 bytes has the least amount of overhead due to frame headers.
- However, the BTU size must be the same at both ends of a connection and, therefore, the same for all the nodes that make up a path through the network.

  This means that it may be necessary to use a less than optimal value of 8000 bytes because some of the equipment used as a network node may have a maximum possible BTU size less than 8000 bytes.

Note: For IP over token-ring, the maximum IP transmission unit (MTU) can be 17 749 bytes. This does not conflict with the 8000-byte maximum BTU size stated above.

Performance Tuning for Token-Ring Links

Attention

Proper operation of the 3746-900 requires correct setting of the NCP parameters. There are parameter values that need to be changed when moving lines from a 3745 adapter to a TRP, TRP2, or TRP3.

When making token-ring link definitions, this section must be used.

Transmission Groups

Link Transmission Group (TGCONF in the PU Statement)

TGCONF specifies whether a subarea link station is in multilink or single-link transmission group (TG). The default is:

```
TGCONF = MULTI
```

To improve the performance of transmission groups that contains a single token-ring line (a single-link TG), code as:

```
TGCONF = SINGLE
```

Load Balancing in a MLTG (MLTGORDR in the BUILD Statement) (MLTGPRI in the LINE Statement)

To balance the traffic load over two or more subarea lines in a MLTG, define the following:

- In the BUILD definition:

  `MLTGORDR=MLTGPRI`

- In the LINE definition for EACH line used set `MLTGPRI` to same value (from 0 to 255).

File Transfer Performance

To increase to the rate of files transfers over your token-ring LAN, use CCM to adjust the values the PIU size, MAXOUT and MAXIN.

The 3746 can both be a transmitter and receiver of token-ring I-frames. If the local 3746 is the transmitter PU, it must be linked to a remote receiver PU, and if the local 3746 is the receiver PU, it must be linked to a remote transmitter PU. In each case, references are made to the transmitter MAXOUT and the receiver MAXIN, but not to the MAXOUT and MAXIN parameters on the same 3746. MAXOUT and MAXIN on the same machine have no relationship to each other.

PIU Size

Set the “Maximum Received PIU size” and “Maximum Sent PIU size” values greater than the CCM defaults. Pay special attention to the Buffer Utilization of the adapter (see the MOSS-E 3746-9X0 Performance Management menu). If the utilization exceeds 70%, then either:

- Decrease the transmission window size (MAXOUT)
- Increase the acknowledgment frequency at the receiver side [MAXIN (N3)].

You may need to try several pairs of values before you get the optimum values for the adapter.

MAXOUT and MAXIN

In the ideal, perfect network, optimal frame transmission/reception would be obtained by setting both the transmitter “Maximum transmitted frames before acknowledgement received” (MAXOUT) and receiver “Maximum received frames before acknowledgement sent” (MAXIN) parameters equal and to their maximum values of 127. Also, the receiver T2 acknowledgement timer would not be needed: the transmitting PU would never stop transmitting I-frames (hang).

Of course, real-world networks have problems that require re-transmission of lost I-frames and have mismatches between the transmitter MAXOUT and receiver MAXIN windows.

The transmitter MAXOUT and receiver MAXIN are generally set much lower than the 127 maximum to reduce the re-transmission of I-frames in case of a frame-loss on the network: the CCM default for MAXOUT is eight, MAXIN is six.

Mismatches where the receiver MAXIN is greater than the transmitter MAXOUT require the use of a receiver T2 timer (default 0.2 seconds). If T2 is set to 0, the transmitter PU must wait until its T1 timer (default 10 seconds) times out (plus the time for the exchange of acknowledgement request and received frames) before starting to transmit I-frames again.

Setting T2 greater than zero (for example, 2 seconds) allows the acknowledgement received frame to be sent much quicker. The transmitter PU can begin transmitting again on receipt of the acknowledgement received frame, which is sent by the receiver PU after time T2. It does not have to wait T1 time (normally much greater than the T2 time) before asking (by sending an acknowledgement request to the receiver PU) if it can send I-frames again.

When the receiver MAXIN is less than the transmitter MAXOUT, the results are the same as when MAXIN equals MAXOUT: there is a constant transmission of I-frames. The receiver T2 and transmitter T1 never time out.

Note: This should always be true: Receiver MAXIN ≤ Transmitter MAXOUT

For file transfer using IP over token-ring, see the note in “Maximum BTU Size (APPN/DLUR and HPR)” on page 23.

Chapter 4. Ethernet Adapters

Availability Notice

Ethernet adapters are no longer available from IBM for the 3746 base frame. For the currently available Ethernet adapters, refer to the *3745 Communication Controller Models A and 170, 3746 Nways Multiprotocol Controller Models 900 and 950: Overview*, GA33-0180.

This chapter tells you how the 3746-9X0 supports your Ethernet networks. An Ethernet port of the 3746 acts as a MAC bridge between an Ethernet LAN and a TIC3.

Note: For details about the Ethernet standard, see Appendix C, "Ethernet (802.3) Standard" on page 53. The port connects either an Ethernet Version 2 or IEEE 802.3 Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Ethernet LAN.

The port is functionally transparent to stations on the Ethernet LAN, appearing as a single native device on the LAN. The stations on the Ethernet LAN appear to the TRP2 as token-ring stations and the port (the bridge) is functionally transparent to any traffic routed by the 3746-9X0.

If you need detailed information on the functions provided by the Ethernet bridge box, refer to the IBM *8229 Bridge Manual*.

Maximum Number of Addresses Allowed

The port supports up to 2048 active stations on Ethernet segments attached to that port, with a maximum of 255 stations per segment.

Information Field Length

The Ethernet port supports frames with a maximum information field of 1500 bytes, which is the maximum supported by Ethernet.

Protocols and Interfaces

The port supports SNA/NCP (3746-900), APPN/DLUR, and HPR traffic on both Ethernet Version 2 and IEEE 802.3 Ethernet.

| **Note:** It is not recommended that you use the Ethernet port as the bridge within an IP network. However, if you must use the Ethernet port, you must use only Routing Information Protocol (RIP) Version 1 as the routing protocol. All other IP protocols require an address mapping within the Ethernet port that imposes major restrictions for IP.

Source Address Database

The Ethernet port dynamically maintains a source address database for each of its LAN connections. This database is held in memory. The Ethernet port uses this database to decide whether or not to forward a frame onward through the 3746-9X0. This requires that:

- The port operates in a *promiscuous* mode so that every frame on the LAN is received.

- The source address from each frame is saved in the database.

The database is searched to determine whether the destination address of the frame is in the database. If the address is:

- Found, the frame is discarded since both the source and the destination stations are on the same LAN.
- Not found, the Ethernet port forwards the frame.

This decision process is a type of *filtering*. The Ethernet database contains the source addresses detected on the Ethernet Version 2 or IEEE 802.3 Ethernet LAN and the frame format that each station uses for data transmission. Entries are created as part of the *learning process* of the port when the port is activated.

Chapter 5. Ethernet Configuration

Availability Notice

Ethernet adapters are no longer available from IBM for the 3746 base frame. For the currently available Ethernet adapters, refer to the *3745 Communication Controller Models A and 170, 3746 Nways Multiprotocol Controller Models 900 and 950: Overview*, GA33-0180.

This chapter tells you how configure the 3746-9X0 support for your Ethernet network ports. The Service Processor provides configuration capability for the port. Table 4 gives the configuration actions that need to be performed.

Table 4 (Page 1 of 2). Configuration Activities for an Ethernet Port (Bridge)

Action by	Configuration Activity
IBM	Install and configure the Ethernet bridge for SNMP. **Note:** You must provide the *IP address* of the bridge plus SNMP parameters so this can be configured by IBM at installation time. See the worksheet in "Parameters for Ethernet Port (Bridge)" on page 31. For a description of SNMP parameters, refer to the "3746 Management Overview" chapter in the *3745/3746 Planning Series: Management Planning*. These parameters are: **Name of the Ethernet bridge** A 3746-9X0 can have more than one bridge, so each bridge must be uniquely identified. **SNMP Community Parameters** These parameters specify an administrative relationship between agents and managers. There are three parts to the community parameters: • Name of the community • IP address of the manager within the community • Privilege (access) mode of the manager: – Read. The manager can only read information. – Read/Write. The manager can both read and write. **Note:** Read/Write applies *only* to the Ethernet network connected to the Ethernet port. It is not implemented for the 3746 Network Node. **Trap Parameters** • Name of the community • IP address of the community manager (0.0.0.0 is not a valid address for a trap community). **SNMP authentication of failure traps** Enabled or disabled

Action by	Configuration Activity
Customer	You must configure your Ethernet port as a TIC3 (token-ring port) in your CCM (APPN/HPR and/or IP) and/or NCP generation. You need to supply the Ethernet frame size used on the Ethernet network connected to this port. To plan your Ethernet definitions, you can use the *3745/3746 Planning Series: CCM Planning Worksheets* located on the Web at: `http://www.ibm.com/networking/did/3746bks.htm#Customer` The parameter values for the Ethernet Bridge component of the token-ring port (refer to the Ethernet port specifications in the "Physical Planning Details" chapter in the *3745/3746 Planning Series: Physical Planning*) are set to their default values and cannot be changed. If you need details of the default values, refer to the IBM *8229 Bridge Manual, GA27-4025*.

Table 4 (Page 2 of 2). Configuration Activities for an Ethernet Port (Bridge)

Appendix A. MOSS-E Worksheets for Controller Installation

Complete these sheets and give them to:

- The IBM service representative (the MOSS-E parameters are needed during controller installation)
- The person doing additional controller configuration using the *IBM 3745 Communication Controller All Models, IBM 3746 Nways Multiprotocol Controller Connection and Integration Guide*.

When applicable, default parameter values are included (in parentheses) in the tables of this appendix.

Parameters for Ethernet Port (Bridge)

The following parameters are discussed in Chapter 5, "Ethernet Configuration" on page 29.

Location and Cable Type

Ethernet bridge name	
Ethernet bridge IP address	
Ethernet attachment type	□ 10 Base T □ *AUI*
TIC3 location (refer to "Familiarizing Yourself with the Installation Sheets" in the *3745/3746 Planning Series: Physical Planning* for the coupler position)	
8229 location	□ controller expansion A □ controller expansion B

SNMP Community Name

Community name	
IP address (in dotted notation) of the community name owner	
Privilege	□ Read □ Write

SNMP Trap Community Name

Trap community name	
IP address (in dotted notation) of the network manager	
Authentication of failure traps	□ Enable □ Disable

Appendix B. Token-Ring (802.5) Standard

The IEEE 802.5 standard describes the token-ring medium access(MAC) protocol and its physical attachments.

In a token-ring network the stations on the LAN are physically connected to a wiring concentrator usually in a star-wired ring topology. Logically, stations are connected in a pure ring topology. Each station has driver and transmitter as well as receiver circuitry; see Figure 7.

Differential Manchester code is used to convert binary data into signal elements, which are transmitted at 1, 4, or 16 Mbps (IEEE standard speeds). The standard does not prescribe the type of cabling to be used. In IBM's token-ring network implementation, shielded twisted pair cabling (STP) is recommended, although unshielded twisted pair (UTP) can now be used.

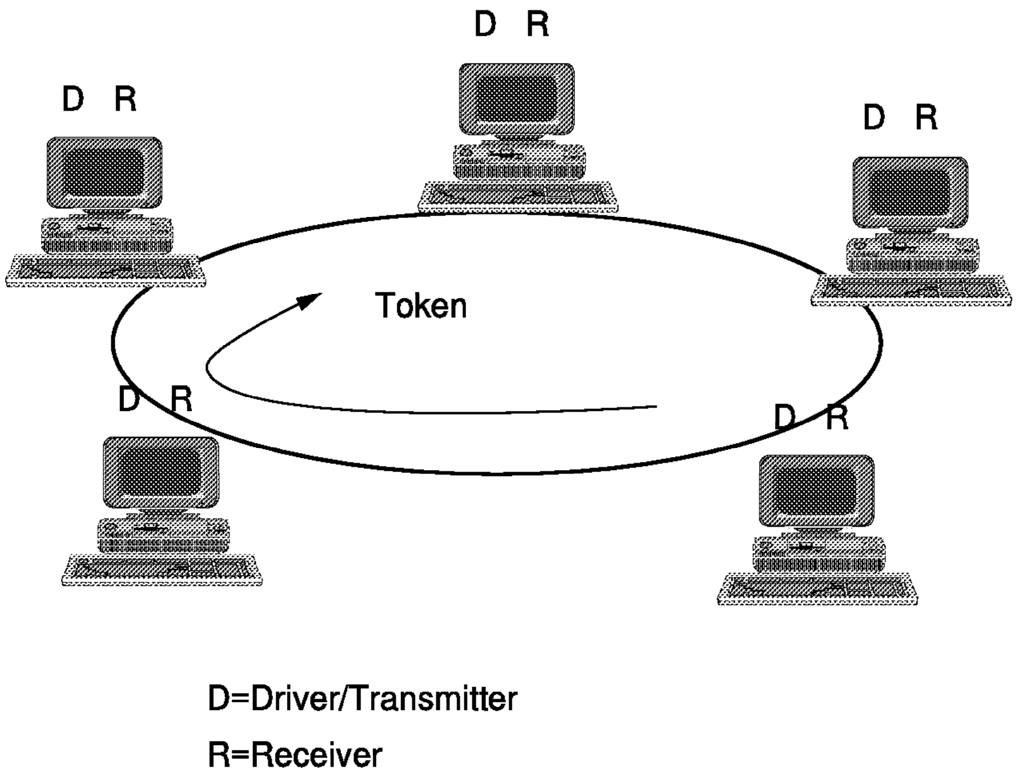


Figure 7. Sample Ring Configuration

Access to the ring is controlled by a circulating token. A station with data to transmit waits for a free token to arrive. When a token arrives, the station changes the token into a frame, appends data to it and transmits the frame. If the destination station is active, it will copy the frame and set the frame copied and address recognized bits, providing MAC-level acknowledgment to the transmitting station.

The sending station must strip the frame from the ring and release a new token onto the ring.

An option in the architecture allows the sending station to release a token immediately after transmitting the frame trailer, whether or not the frame header information has already returned. This is called early token release and tends to reduce the amount of idle time in 16 Mbps token-passing rings.

The token-passing protocol provides an extensive set of inherent fault isolation and error recovery functions, for implementation in every attaching device. The adapter network management functions include:

- Power-on and ring insertion diagnostics
- Lobe-insertion testing and online lobe fault detection
- Signal loss detection, beacon support for automatic test and removal
- Active and standby monitor functions
- Ring transmission errors detection and reporting
- Failing components isolation for automatic or manual recovery.

The token-passing ring medium access protocol will be described in the following sections.

In summary, the token-passing ring protocol has the following elements:

- Active monitor
  - Ensures proper ring delay
  - Triggers neighbor notification
  - Monitors token and frame transmission
  - Detects lost tokens and frames
  - Purges circulating tokens or frames from the ring
  - Performs auto-removal in case of multiple active monitors.
- Standby monitor (any other ring station)

  Detects failures in the active monitor and disruptions on the ring.
- Token claiming process

  A new active monitor is elected when the current active monitor fails. This process may be initiated by the current active monitor or by a standby monitor.

Figure 8 on page 35 shows the format of an 802.5 standard MAC frame as well as the token format and the format of the abort delimiter.

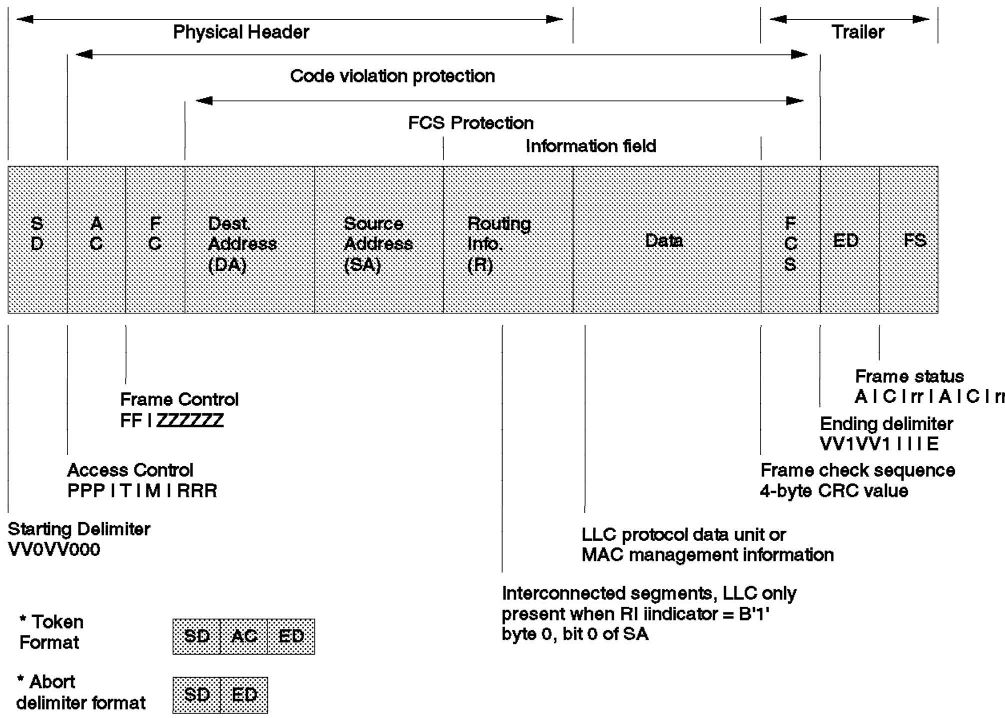


Figure 8. 802.5 Standard MAC Frame

The architecture describes 28 different MAC control frames, each identified by a unique major vector identifier (MVID). The main ones will be described in the following sections and are referred to as:

- Active Monitor Present MAC frame
- Ring Purge MAC frame
- Standby Monitor Present MAC frame
- Claim Token MAC frame
- Lobe Media Test MAC frame
- Duplicate Address Test MAC frame
- Request Initialization MAC frame
- Beacon MAC frame
- Soft Error Report MAC frame

Token-Ring Concepts

A token-ring network consists of the attaching medium and ring stations (devices able to attach to the ring and to use the link access protocols). A token-ring network uses one of several twisted pair media specifications, each having its own price/performance ratio, and all suitable to carry most other data communications signals. A token-ring network may also use optical fiber media.

A token-ring LAN installation is illustrated in Figure 9 on page 36.

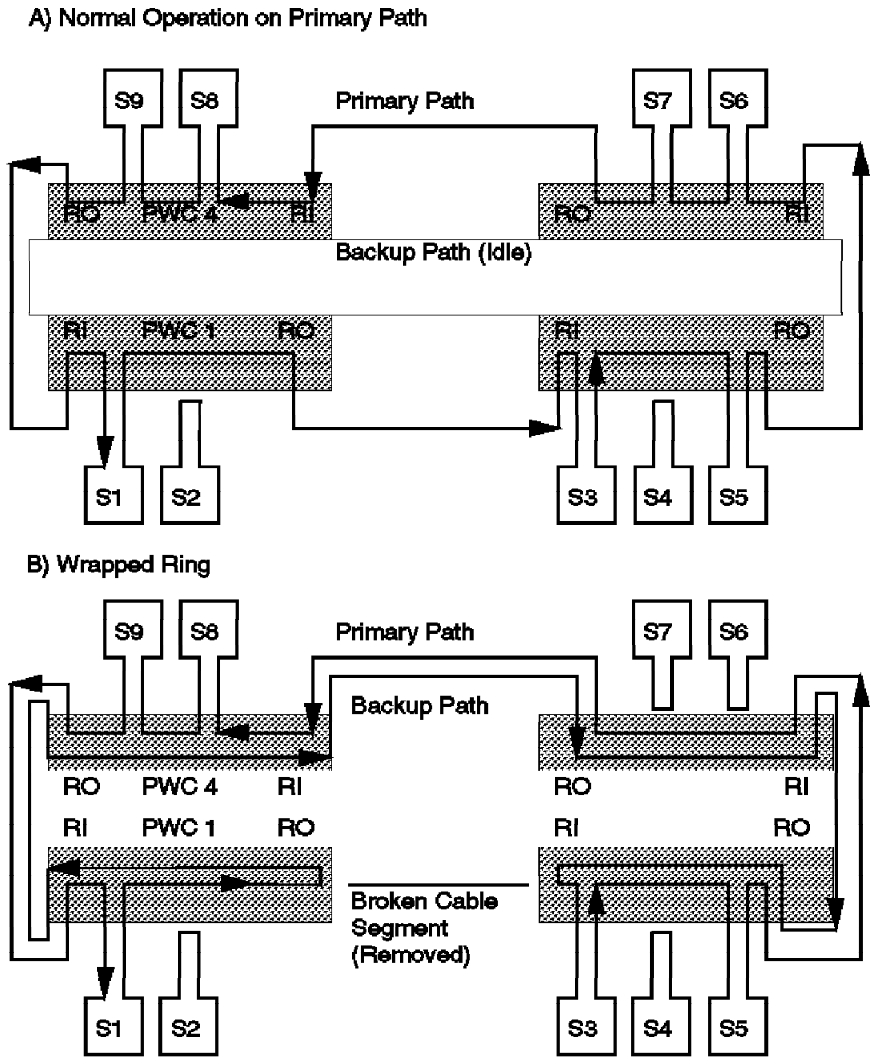


Figure 9. Normal and Wrapped Token-Ring LANs

This figure shows four passive wiring concentrators (PWCs) and nine physically attached nodes. The power from the attached nodes when transmitted to the concentrator activates relays in the concentrator to allow the station to send signals across the LAN to other stations. In Part A of Figure 9, adapters (nodes S2 and S4) have not powered their respective PWC relays and, therefore, their lobe wires are internally bypassed. In part B of Figure 9, four adapters (nodes S2, S4, S6 and S7) are not actively inserted into the ring (their lobe wires are internally bypassed) and the primary path is wrapped to the backup path in PWCs 1 and 2.

When a cable segment between PWCs fails, manual removal from the appropriate ring-in and ring-out connectors causes automatic wrapping of the primary path to the backup path. How such a permanent wire fault is reported for LAN management is explained in the discussion of beaconing later on in this section. Recovery from the same error is automatic when using the IBM 8230 Controlled Access Unit, which is an active, or powered, wiring concentrator.

A ring station transfers data to the ring, in a data transmission unit called a frame. Frames are sent sequentially from one station to the next station physically active on the ring. This station is called the downstream neighbor. Each ring station repeats the frame. While doing so it performs error checking on the bit stream and it will copy the data if its own address, either its MAC or any of its functional addresses, are identified as a destination station in the frame. Upon return of the frame to the originating station, the latter will remove the data from the ring. In a token-passing protocol, a ring station can only transfer data to the ring while it is holding a token. The token is a specific bit sequence (24 bits) circulating around the ring at a rated speed of 100 Mbps according to the Fiber Distributed Data Interface specification. (4 Mbps or 16 Mbps in current implementations).

Distributed Data Interface Specification

Because of the high transmission speed with respect to the total ring length, a short ring might contain only a few bits at any point in time. Only one token may exist on a ring segment at any given point in time. Therefore, a delay equivalent to the time it takes for a token to circulate the ring is required to ensure that no overrun occurs which would result in a station receiving a token that it is transmitting and thinking that a second token exists on the ring. For a 24-bit token this means a minimum 24-bit delay. In addition to this delay, an additional elastic buffer is introduced to support the token protocols and speed.

In order to establish communication between any two ring stations, addressing mechanisms are needed. At the same time the integrity of the transmitted frames between ring stations must be preserved. Therefore, data checking capabilities are required at the MAC level of a ring station.

MAC Addressing

All ring stations are identified by a unique individual address. This address can be universally administered, assigned by the IEEE organization. Because it is set in read-only memory (ROM) on a token-ring adapter card, the universally administered address is also called a burned-in address.

Some manufacturers have been assigned universal addresses that contain an organizationally unique identifier. For instance, IBM has an identifier of x'10005A'. All IBM Token-Ring cards that use IBM Token-Ring chip sets have the first 6 digits of their address begin with those characters. Other identifiers are x'000143' for IEEE 802, and x'1000D4' for DEC. IEEE universal addresses, whether for token-ring or 802.3 stations, are all allocated out of the same common pool, but uniqueness is guaranteed.

A ring station’s individual address can also be locally administered, that is set at adapter-open time and typically defined by a network administrator. A number of destination ring stations can be identified by a group MAC address. Some standard group addresses have been defined. These are listed in Table 5.

Table 5 (Page 1 of 3). Standardized Group Addresses

Bridge	X'8002 4300 0000'
Bridge management	X'8001 4300 0008'
Load server	X'8001 4300 0088'
Loadable device	X'8001 4300 0048'

Table 5 (Page 2 of 3). Standardized Group Addresses	
ISO 10589 level 1 1 intermediate stations	X'8001 4300 0028'
ISO 10589 level 2 1 intermediate stations	X'8001 4300 00A8'
FDDI RMT directed beacon	X'8001 4300 8000'
FDDI status report frame	X'8001 4300 8008'
OSI network layer end stations	X'9000 D400 00A0'
OSI NL intermediate stations	X'9000 D400 0020'
Reserved for transparent bridging	X'8001 4300 000x'
All LANs bridge mgt group address (802.1D)	X'8001 4300 0008'
All cons end systems (ISO 10030)	X'8001 4300 0068'
All cons snares (ISO 10030)	X'8001 4300 00E8'
FDDI all root concentrator MACs (ANSI X3T9.5)	X'8001 4300 1004'
Reserved for FDDI	X'8001 4300 10X0'
Loopback assistance	X'F300 0000 0000'
AppleTalk support	X'9000 E000 0000'
AppleTalk highest address within range except broadcast	X'9000 E000 003F to X'9000 E0FF FFFF'
Novell IPX	X'9000 7200 0040'
Hewlett Packard probe	X'9000 9000 0080'
HP DTC	X'9000 9000 0020'
Apollo domain	X'9000 7800 0000'
Vitalink diagnostics	X'9000 3C40 00A0'
Vitalink gateway	X'9000 3CA0 0080'
LANtastic	X'FFFF 0006 0020'
LANtastic	X'FFFF 0002 0080'
LANtastic	X'FFFF 8007 0020'
Concord DTQNA	X'0000 9640 XXXX'
DEC DNA Dump/load assistance (MOP)	X'D500 0080 0000'
DEC DNA remote console (MOP)	X'D500 0040 0000'
DNA level 1 routing layer	X'D500 00C0 0000'
DNA routing layer end nodes	X'D500 0020 0000'
Customer use	X'D500 2000 XXXX'
System Communication Architecture	X'D500 2080 XXXX'
VAXELN	X'D500 D400 0040'
LAN traffic monitor	X'D500 D400 00C0'
CSMA/CD encryption	X'9000 D400 0060'
NetBIOS emulator (PSCG)	X'9000 D400 00E0'
Local area transport (LAT)	X'9000 D400 00F0'
All bridges	X'9000 D480 0000'

Table 5 (Page 3 of 3). Standardized Group Addresses	
All local bridges	X'9000 D480 0080'
DNA level 2 routing layer routers	X'9000 D440 0000'
DNA naming service advertisement	X'9000 D440 8000'
DNA naming service solicitation	X'9000 D440 8080'
LAT directory service solicit (to slave)	X'9000 D440 8020'
FDDI ring purger advertisement	X'9000 D440 80A0'
LAT directory service solicit - X service class	X'9000 D440 80D0'
Local area system transport (LAST)	X'9000 D420 XXXX'
UNA prototype	X'5500 C000 XXXX'
Prom 23-365A1-00	X'5500 C080 XXXX'
Misc.	X'5500 C040 XXXX'
H400 - TA Ethernet transceiver tester	X'5500 C040 0000'
NI20 products	X'5500 C0C0 XXXX'
DECnet phase IV station addresses	X'5500 2000 XXXX'
Prom 23-365A1-00	X'1000 D40X XXXX'
Prom 23-365A1-00	X'1000 D48X XXXX'
Bridge mgt.	X'1000 D444 0000'
Prom 23-365A1-00	X'1000 D4C4 XXXX through X'1000 D4CX XXXX'
Shadow for prom 23-365A1-00	X'1000 D42X XXXX'
Shadow for prom 23-365A1-00	X'1000 D4AX XXXX'
Shadow for prom 23-365A1-00	X'1000 D4B6 XXXX' through X'1000 D4EX XXXX'
VAXft 3000 fault-tolerant LAN addresses	X'1000 D407 XXXX'
VAXft 3000 fault-tolerant LAN addresses	X'1000 D40F XXXX'

A token-ring LAN also provides a special case of a locally administered group address called functional addresses. Each (bit-significant) functional address represents a well-identified server function within the access protocol. Of 31 possible functional addresses, 22 have been defined while the remaining ones are reserved for future use or may be user-defined. They are listed in Table 6 on page 40.

Table 6. New and Current IEEE and IBM Functional Addresses	
Active monitor	X'C000 0000 0001'
Ring parameter server	X'C000 0000 0002'
Network server heartbeat	X'C000 0000 0004'
Ring error monitor	X'C000 0000 0008'
Configuration report server	X'C000 0000 0010'
Synchronous bandwidth mgr	X'C000 0000 0020'
Locate - directory server	X'C000 0000 0040'
NetBIOS	X'C000 0000 0080'
Bridge	X'C000 0000 0100'
IMPL server	X'C000 0000 0200'
Ring authorization server	X'C000 0000 0400'
LAN gateway	X'C000 0000 0800'
Ring wiring concentrator	X'C000 0000 1000'
LAN manager	X'C000 0000 2000'
User-defined	X'C000 0000 8000' through X'C000 4000 0000'
ISO OSI ALL ES	X'C000 0000 4000'
ISO OSI ALL IS	X'C000 0000 8000'
IBM discovery non-server	X'C000 0001 0000'
IBM resource manager	X'C000 0002 0000'
TCP/IP	X'C000 0004 0000'
6611-DECnet	X'C000 2000 0000'
LAN Network Mgr & 6611	X'C000 40000 0000'

The most relevant protocol server functions will be described in greater detail in the Bridge and LAN management sections of *Local Area Network Concepts and Products: Routers and Gateways*.

In addition, two special destination address values have been defined. The all-stations broadcast group address X'FFFFFFFFFFFF' identifies all ring stations as destination stations. A frame carrying the individual null address X'000000000000' as its destination MAC address is not addressed to any ring station; therefore, it can be sent but not received.

IEEE allows vendors to implement either 16-bit or 48-bit MAC addresses. The actual address field formats are shown in Figure 10 on page 41.

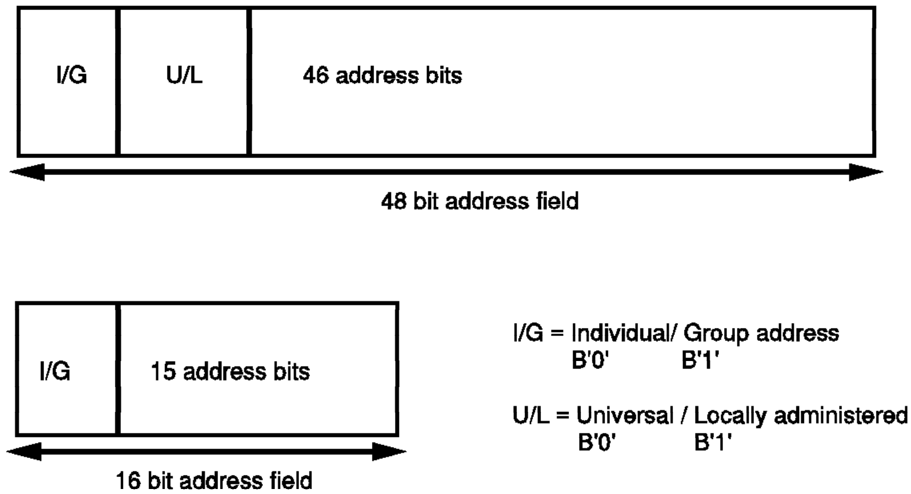


Figure 10. IEEE LANs - MAC Address Format

For the IBM LAN implementations, 48-bit addressing has been selected. The implementation format is shown in Figure 11.

Figure 11. IBM Token-Ring Network - MAC Address Format

- The reserved bits are set to B'0' for locally administered addresses.
- Functional address indicator = B'0' indicates a functional address if I/G = B'1' (indicating a group address).
- For individual locally administered addresses, FAI must be B'0' by convention. This is an addressing anomaly.

These rules yield valid address ranges as described in Figure 12 on page 42 for any IBM Token-Ring Network adapter.

	I/G	U/L	FAI	Definition/range
Individual Universally Adm.	0	0	0/1	Mfg_code ,S/N IEEE assigned
Individual Locally Adm.	0	1	0	X'4000 0000 0000' to X'4000 7FFF FFFF'
Group address	1	1	1	X'C000 8000 0000' to X'C000 FFFF FFFF'
Functional address	1	1	0	X'C000 0000 0001' to X'C000 FFFF 2FFF' (bit sensitive)

Figure 12. Valid Address Ranges

Data Transmission

The transmission technique used in token-passing rings is *baseband transmission*. In a token-ring LAN, high-order bytes/bits are transmitted first; that is, byte 0 is transmitted before byte 1 and high-order bit 0 within a byte (of 8 bits) is transmitted first. This transmission order can be different for other types of LAN segments using different access protocols, for example, CSMA/CD. Opposite transmission order might be a diagnostic consideration when evaluating trace information from LAN segments of a different nature because of the possible need to reorder the bits. The ability to reorder the bits without significant performance degradation can also be a functional requirement of the bridge products being considered for a LAN segment interconnection. Figure 13 on page 43 shows the format of the information to be transmitted on a token-passing ring.

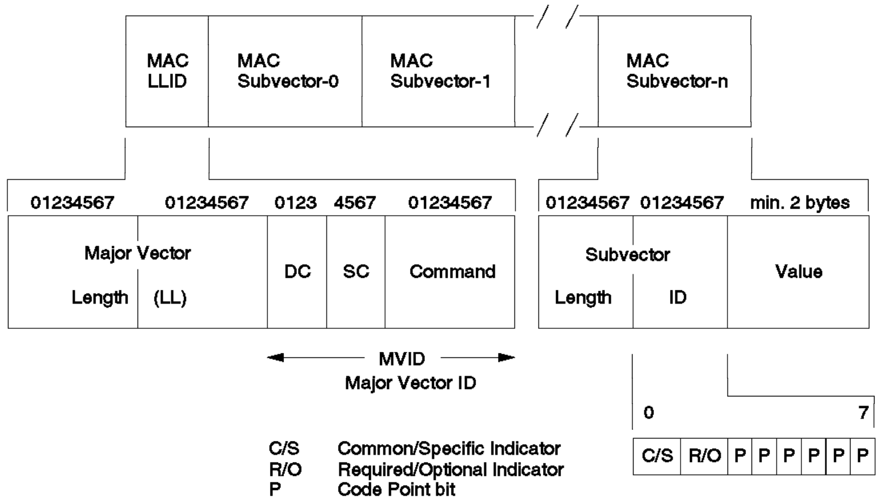


Figure 13. Token-Ring MAC Frame - Data Field Format

Examples of MVID code points are X'05' to indicate an Active Monitor Present MAC frame, X'02' for a Beacon MAC frame, etc. Unique MVID values for 28 different MAC frames have been defined. A complete description can be found in *IBM Token-Ring Network Architecture Reference,*. Subvectors provide additional information depending on the specific major vector identifier. MAC frames are processed according to destination and source function classes, including:

- **Ring Station**

  These are the functions necessary for connecting to the LAN and for operating with the token-ring protocols. A ring station is an instance of a MAC sublayer in a node attached to a ring.

- **DLC_LAN_MGR**

  The manager function of the data link control component activates and deactivates ring stations and link stations on command from the physical device. It also manages information transfer between data link control and the physical device.

- **Configuration Report Server (CRS)**

  The CRS function can reside on each ring in a multisegment environment in which configuration is being monitored. This function receives notifications about station insertion and removal, and notifications about active monitor failures.

- **Ring Parameter Server (RPS)**

  The RPS function can reside on every segment in a multisegment ring environment on which operational parameters are centrally managed. It may provide operational values to attaching stations upon request. For example, a ring station will request such parameters as ring number upon insertion into the ring.

- **Ring Error Monitor (REM)**

  The REM server function is present on segments for which errors are to be monitored or analyzed. It collects error information from LAN stations attached to the local ring, analyzes soft error reports and possibly forwards error reports to a LAN Manager.

- **RPL Server**

  The RPL server function and its RPL functional address are involved during the power-on process of a LAN station equipped with the remote program load feature. Such a station will insert into the ring to find a control program server on the ring from which to down load its control program and complete its initialization processes.

- **The Token-Passing Ring Protocol**

  To transmit data on the LAN medium, a ring station captures a token and sets the token bit in the access control field to identify that the data being transmitted is a frame. To this header, the transmitting station appends destination and source MAC addresses, data, a newly calculated frame check sequence field, and the ending delimiter and frame status fields.

  Any subsequent station will receive and retransmit the frame while performing a CRC check. Such a station is said to be in normal repeat mode.

  In general, a ring station in normal repeat mode checks the data in the tokens and frames it receives and sets the error-detected, address recognized or frame copied bits in a frame (bits E, A, or C) as appropriate while repeating the signal. A destination station will copy the data (frame copied) and pass the frame on. While processing the frame trailer, the destination station marks the A and C bits. Upon return to the originating ring station, the frame is removed from the ring and the A and C bits in the frame trailer's FS field are checked to see if the frame was recognized and read by the destination station or a bridge (this occurs for MAC frames only). When the frame header is received by the originating station the originating ring station must release a new token, possibly at a different priority level, for another ring station to capture and proceed with data transmission. The priority reservation bits in the access control field of the returned frame together with stored priority levels in the originating station determine the priority of the new token. See "Access Priority" on page 49 for details.

  This protocol is called a single token protocol, because only one token can circulate on the ring at any time.

Early Token Release

If an originating station releases a new token only when the frame header has circulated around the ring back to the source and the frame transmission time is shorter than the ring transmit time, then the originating station must generate idles until a header is received.

Token-passing ring protocols define the length of a token to be 2 bits and the shortest possible MAC frame to be 200 bits long. On a 4-Mbps token-ring LAN where the length of 1 bit is roughly 50 m (165 ft), a complete token is 1200 m (4000 ft) long while the shortest frame length would be 10 000 m (33 000 ft). Therefore, at 4 Mbps, the percentage of potential bandwidth which remains idle can be extremely small (that is high bandwidth utilization can be maintained at higher traffic levels).

If, however, there is a 16-Mbps token-ring LAN, where 1 bit is 12.5 m (42 ft) long, along with a complete token and the shortest possible MAC frame, both become four times smaller–300 m (1000 ft) and 2500 m (8500 ft), respectively. You can optimize the utilization of the medium by reducing the idle time required by waiting for a header. Obviously, when moving to even higher transmission speeds (for example, a 100-Mbps FDDI LAN), the token-passing protocol must be adjusted to achieve better utilization of the potential bandwidth.

The architecture provides an option called *early token release.* With this option a transmitting station will release the token after completing the transmission of the data frame before the receipt of the header of the transmitted frame; they thereby eliminate the idle time while waiting for the header to reappear. When such early release has occurred, an adapter indicator is set to prevent the adapter from releasing another token upon return of the frame header. This allows multiple frames but still only one token on the LAN.

The early token release option is enabled by default on the 16 Mbps IBM token-ring Network. It is an option for each station, and it is not required that all stations implement the option but is recommended.

Token Monitoring

Token-passing protocols provide relatively greater control and management at the medium access control (MAC) level than that provided by CSMA/CD protocols. The token-passing ring protocol concepts, described in the following sections, are implemented in the adapters themselves. They contribute to the availability, performance and manageability of a token-ring LAN. At any point in time, one and only one station per segment performs an active monitor function. Any ring station can act as the active monitor. Only one will have this function enabled. Active monitor tasks support the monitoring of the token and other ring management functions such as:

- Detection and recovery of a lost token or frame, including initiation of a token when a ring is started
- Detection and recovery of a circulating priority token or frame
- Detection and recovery of multiple tokens on the ring
- Detection and recovery of multiple active monitors
- Timing control to ensure accurate transmission regardless of the ring length

All other ring stations are *standby monitors*, prepared to take over the active monitor function should it fail. The following description summarizes how the active monitor performs its ring management tasks:

- In every transmitted token or frame, the monitor bit (M) in the access control field is initially set to B'0'. As the active monitor repeats a frame or non-zero priority token, the M-bit is set to B'1'. If the M-bit had already been set to B'1', the active monitor assumes that the frame or token has already circled the ring once and that the originating station has not been able to remove the frame or priority token. The active monitor will purge the ring and generate a new token.
- To ensure that a complete (24-bit) token can be transmitted before the token returns to the originating ring station, the active monitor introduces a 24-bit ring delay.
- The active monitor periodically broadcasts (every seven seconds) an Active Monitor Present MAC frame. This forces each station on its ring to acquire the

address of its nearest active upstream neighbor (NAUN) and to initiate a number of control timers within each station. This information is used when isolating errors on a segment.

- Loss of a token or frame is detected by expiration of an any-token timer whose timeout value exceeds the time required for the longest possible frame to circle the ring. The active monitor restarts this timer each time it transmits a starting delimiter. Upon expiration of this timer, the active monitor assumes a lost token or frame, purges the ring and originates a new token. The any-token timer value is defined as the sum of the physical trailer transmission delay plus the delay to transmit the longest frame. The IEEE 802.5 name for this timer is Valid_Transmission_Timer.

Ring Purge

To purge the ring, the active monitor broadcasts a Ring Purge MAC frame (indicated by X'04' in the frame control field) before originating a new token. Return of the Ring Purge MAC frame indicates proper signal propagation around the ring. The Ring Purge frame resets the ring stations to normal repeat mode, canceling or restarting all the appropriate timers. The active monitor starts a Ring-Purge timer when sending the purge frame. This timer will expire if the frame cannot circulate and the monitor will enter a recovery process called a Claim Token.

Neighbor Notification

The neighbor notification process begins when the active monitor transmits an Active Monitor Present MAC frame to all stations on the ring (single ring broadcast). The first ring station that receives the Active Monitor Present MAC frame copies it (if possible) and sets the address-recognized (A) and frame-copied (C) bits to B'1'. It then saves the source address from the copied frame as its NAUN address (the address of the active monitor) and starts a timer called the Notification-Response timer.

All other active stations on the ring repeat, but do not otherwise process the Active Monitor Present MAC frame because the frame's A and C bits have already been set.

When the Notification-Response timer of the first station downstream from the active monitor expires, it broadcasts a Standby Monitor Present MAC frame.

The next ring station downstream copies its NAUN address from the source address field of the Standby Monitor Present frame, sets the A and C bits to B'1', and starts its own Notification-Response timer. When this timer expires, this station in turn transmits its Standby Monitor Present MAC frame.

In this way, neighbor notification proceeds around the ring, with each ring station receiving and transmitting Standby Monitor Present MAC frames until the active monitor copies its NAUN address from a Standby Monitor Present MAC frame. The active monitor then sets the Neighbor - Notification Complete flag to B'1', indicating that the process has been successfully completed. Neighbor notification thus enables a ring station to learn its NAUN address, and to provide its address to its downstream neighbor.

Standby Monitor

Any ring station that is not performing the active monitor function acts as a standby monitor. Its purpose is to detect a failing active monitor and disruptions on the ring.

Each time a token or frame is repeated, a standby monitor restarts its good-token timer to verify the presence of an active monitor.

A second timer, the Receive-Notification timer, is restarted by a standby monitor each time it copies an Active Monitor Present MAC frame. If any of these two timers expires, the standby monitor station will initiate the token-claiming process.

The Token-Claiming Process

This process, also called the monitor-contention process, is the procedure by which ring stations elect a new active monitor. This process is started upon any of the following conditions when:

- The active monitor detects the following states or events:
  - Loss of signal.
  - The Active Monitor Present MAC frame does not return (Receive-Notification timer expires).
  - Failure of Ring-Purge MAC frames to return completely (Ring Purge timer expires).
- A standby monitor detects the following states or events:
  - Loss of signal
  - Absence of active monitor's token management functions (good_token timer expires).
  - Missing Neighbor_Notification process (Receive-Notification timer expires).
- A ring station attaches to the ring and does not detect an active monitor (for example, when it is the first station on the ring).

The ring station detecting one of these conditions enters Claim-Token-Transmit mode by broadcasting a Claim Token MAC frame and repeating it at a defined interval. Each participating ring station compares the address in the Claim Token MAC frame's source address field to its own.

- If the source address is greater than the ring station's address, the station enters Claim Token Repeat operating mode.
- If the source address is less than the ring station's address, the station transmits its own Claim Token MAC frames.
- If the source address is the same as the ring station's address, it continues broadcasting until it has received three of its own Claim Token MAC frames. This indicates that the ring is viable and the station has won token-claiming.

  The station then adds the token delay to the ring, purges the ring, starts its active monitor timers, and releases a new token. It is now the new active monitor.

Ring Station Insertion

This process is executed by any ring station when entering the ring. It is also known as the five-phase insertion process.

- Phase 0: Lobe testing

  A series of Lobe Media Test MAC frames are sent on the lobe wire to the multistation access unit. The signal is wrapped at the entry into the multistation access unit causing the frames to return to the station. Then the receive logic is tested. If the tests are successful, a 5 volt dc current (also called *phantom current*) is sent to open the relay and attach to the ring.

- Phase 1: Monitor check

  The attaching station starts its Insert timer, and watches for an Active_Monitor_Present, Standby_Monitor_Present or Ring Purge MAC frame before this timer expires. If the timer expires, token-claiming is initiated. When it is on the first station on ring, the attaching station will become the active monitor.

- Phase 2: Duplicate address check

  The station sends a Duplicate Address Test MAC frame (destination address = source address = station's unique address). If a duplicate address is found (A-bit = B'1'), the station detaches from the ring.

- Phase 3: Participation in neighbor notification

  The station learns its nearest active upstream neighbor (NAUN) and reports its own address to its nearest active downstream neighbor.

- Phase 4: Request initialization

  A Request Initialization MAC frame is sent to the ring parameter server, if present (if not, default values will be used). The ring parameter server responds with an Initialize_Ring_Station MAC frame. Parameters which can be set are physical location, soft error report timer value, ring number and ring authorization level. In this way the last three parameters may be set to the same values for all stations on the ring.

Hard-Error Detection and Reporting

A hard error is a permanent fault that stops normal traffic on the ring. It is usually detected first at the receive side of the ring station downstream from the fault. A change in ring configuration is required to bypass such a fault and to restore normal operation. Reconfiguration might be the result of automatic recovery or, if this process fails to bypass the error, it might require manual intervention.

When a ring station detects a hard error, it starts transmitting beacon MAC frames at a specified time interval until its input signal is restored or until it removes itself from the ring. The detecting station also starts a Beacon timer. All other stations enter beacon repeat mode when they receive a beacon MAC frame.

A beacon frame identifies the address of the nearest active upstream neighbor of the beaconing station as well as error type information. When the beaconing station's NAUN has copied a number of these beacon frames, the NAUN will go offline and perform microcode and lobe tests. If the tests are successful, the station reattaches to the ring immediately. If the tests fail, the station stays offline.

When the beacon timer expires in the detecting (beaconing) station, and normal traffic has not been restored, the station assumes that its NAUN went offline, found no errors and came back online. It will now go through the same process as its NAUN. If the tests fail, the beaconing station remains detached. If successful, the station reattaches immediately. In the latter case, normal traffic may not have been restored during automatic recovery. Network management will be informed and manual intervention will be required. While reporting a permanent hard error, a set of adapter addresses is provided to identify the faulty part of the ring as a small fault domain.

Soft-Error Detection and Reporting

Intermittent faults that temporarily disrupt normal operation of the ring are called soft errors. They are usually tolerated by error recovery procedures but they may impair normal ring operation if excessive or non-random. The most critical soft errors are monitored in each ring station by a set of counters. Every 2 seconds the values of the soft error counters are sent as a Soft Error Report MAC frame to the Ring Error Monitor functional address (typically residing in a bridge or LAN Manager station), where the values for each counter are accumulated. If a soft-error counter exceeds a predefined threshold, a LAN Manager will be informed through its link with the LAN reporting mechanism. The LAN Manager may reconfigure the ring to bypass a faulty node, if the fault can be located.

Soft errors are called *isolating* if a fault domain can be specified. If not, they are called *non-isolating* soft errors.

Access Priority

The following discussion on access priority applies both to 4 Mbps and 16 Mbps token-ring LANs and is an integral part of the token-passing ring protocol. This access priority architecture is not applicable to the FDDI protocol where access priority is based upon timers rather than the contents of an access control field.

As stated earlier, access priority in a token or frame is indicated by the first three bits (PPP) of the access control (AC) field. Any reservation of a priority level is indicated in the last three bits (RRR) of the AC field by a station requiring higher transmission priority.

A ring station wishing to transmit a frame at a given priority can use any available token with a priority level equal to or less than the priority of the frame to be transmitted. If such a matching token is not available, the ring station may reserve a token of the required priority in a passing token or frame according to the following rules:

- If the passing token or frame already contains a priority reservation higher than the desired one, the ring station must leave the RRR bits unchanged.
- If the RRR bits have not yet been set (RRR = B'000'), or indicate a lower priority than the desired one, the ring station will set the reservation bits to its required priority.

Upon removal of a frame by its originating station, the reservation bits in the header are checked. If they show a non-zero value, the station must release a non-zero priority token. The actual priority of the new token is based on the priority used by the ring station for the recently transmitted frame, the reservation received upon return of the frame and any stored priority.

A ring station originating a token of higher priority enters priority-hold state, (also called a stacking station in the IEEE 802.5 token-passing ring standards).

Table 7 lists the priority definitions as provided by the IBM Token-Ring Network architecture.

This protocol option however, impacts the priority handling mechanism, since a new token may be transmitted by the originating station before it is able to verify the access control field in its returned frame.

If the frame header was already received, the token will be issued according to the priority and reservation requested in the AC field of the frame and the resulting priority levels stored in the station.

If the frame header has not yet been completely received by the originating station, the token will be released with the same priority and reserved priority as the transmitted frame.

Table 7. Token-Passing Ring Protocol - Priority Allocation Table

B'000'	Normal user priority-MAC frames that need no token response type MAC frames
B'001'	Normal user priority
B'010'	Normal user priority
B'011'	Normal user priority - MAC frames that need token
B'100'	Bridge
B'101'	Reserved for IBM
B'110'	Reserved for IBM
B'111'	Specialized station management

To prevent a high-priority station from monopolizing the LAN medium and to make sure the priority eventually can come down again, the protocol provides fairness within each priority level.

Additional Token-Ring Considerations

Using an average frame size of 1000 bits to simulate the performance of a 4-Mbps token-passing ring with 100 active LAN devices results in a maximum throughput of about 3.6 Mbps. The token-passing protocol appears to be particularly stable and most efficient even under high load conditions.

The impact of increased transmission speeds, increased numbers of attached stations, or increased transmission distances on a token-passing LAN is significantly less than similar changes on a CSMA/CD LAN. Because each station regenerates the signal, increased distances are easier to support, while transmission speed is primarily limited by the choice of media. The use of bridges to provide additional device capacity and/or distance is an attractive growth option because the absence of collisions simplifies the processing requirements of bridges and maintains the deterministic characteristics of the protocols.

In a token-passing ring, fairness in the access protocol and high-priority utilization by the bridge helps avoid frame loss. Even when a frame is rejected due to bridge congestion, successful recovery is simplified by the protocol.

Token-Ring Summary

The token-passing protocol provides for efficient use of the media under both light and heavy traffic loads. It guarantees fair access to all participating stations. This fairness is enhanced by an eight-level priority mechanism, based on priority reservations made in a passing token or frame. A key benefit of the token-passing ring protocol is its ability to handle increased traffic loads or peaks, making it an ideal protocol for larger and/or more heavily used LANs (including backbone rings). This also makes it a good base LAN for connection to even higher bandwidth LANs such as FDDI.

Appendix C. Ethernet (802.3) Standard

This appendix provides background information about IEEE 802.3 Ethernet local area networks (LANs). It is intended to provide the readers with a brief introduction to the various protocols and topologies used in designing today's LANs.

Ethernet and IEEE 802.3

Ethernet (802.3) is currently the most widely used LAN protocol in the world. Since its introduction to the marketplace in the 1970s it has been established among a wide range of users.

Invented by Xerox in the early 1970s and brought to the marketplace as Ethernet V.1, the protocol was then developed by a consortium of DEC, Intel and Xerox. This consortium brought out a new version of Ethernet in 1980 called Ethernet (DIX) V2. They also published the architecture and took it to the Institute of Electrical and Electronics Engineers (IEEE) to have it accepted as an international standard. The IEEE ratified the Ethernet DIX V2 standards with some slight modifications as IEEE 802.3. The 802.3 standard has since been approved by a number of other organizations, including the American National Standards Institute (ANSI) and the International Organization for Standardization (ISO 8802-3).

Today, both Ethernet and 802.3 LANs are widely implemented across all areas of the marketplace. It has not, as was widely predicted, been replaced by token-ring.

This is largely due to the fact that although the protocol used by Ethernet/802.3 LANs has not changed, the physical topology over which they can be implemented has changed significantly. This has enabled users to have access to some of the benefits (such as manageability) offered by other topologies such as token-ring while still enjoying the perceived advantages of Ethernet/802.3, which include:

- Wide choice of equipment
- Low cost of equipment

Though Ethernet and 802.3 are not identical, the term *Ethernet* is widely used to describe LANs that use either protocol. As most of the information in this chapter applies equally to both Ethernet and 802.3 LANS, the term Ethernet (802.3) will be used throughout this chapter. However, where there are differences, they will be indicated by using the appropriate terminology.

Note: Both Ethernet and the 802.3 protocol can be used on the same physical network simultaneously. However, stations using one protocol cannot interoperate with stations using the other protocol. This is due to the differences that will be explained later in this chapter.

Please note that this appendix will cover Baseband Ethernet only.

CSMA/CD

Carrier Sense Multiple Access/Collision Detection (CSMA/CD) is the name of the protocol used on the Ethernet (802.3) bus to control the operation of the network.

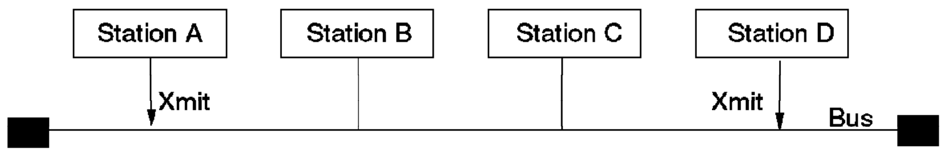


Figure 14. Ethernet CSMA/CD Bus

In a CSMA/CD bus, when a station wants to transmit data on the network bus, it first listens to see if the bus is free (that is no other station is transmitting). If the bus is available, the station starts transmitting data immediately. If the bus is not available (that is another station is transmitting), the station waits until the activity on the bus stops and a predetermined period of inactivity follows before it starts transmitting.

If there is a *collision* after transmission (that is another station starts to transmit at the same time), the stations will stop transmitting data immediately after the collision is detected, but they continue to transmit a jamming signal to inform all active stations about the collision.

In response to this signal, each transmitting station stops transmitting and uses a binary exponential back-off algorithm to wait before attempting to transmit again. This causes each station to wait for a random amount of time before starting the whole process again, beginning with the process of carrier sensing. If a station's subsequent attempt results in another collision, its wait time will be doubled.

This process may be repeated up to 16 times, after which the station, if still unsuccessful, reports a transmission error to the higher-layer protocols.

The process of *collision detection* varies according to the type of media used in the LAN. This process is described in "CSMA/CD" on page 53.

The probability of a collision occurring is proportional to the number of stations, the frequency of transmissions, size of frames and length of the LAN. Therefore, care must be exercised in designing LANs with an excessive number of stations that transmit large packets at frequent intervals. Also, you must ensure that the length of individual *segments* and total length of the LAN does not exceed a certain length as defined by the 802.3 standards. These limitations are discussed later in this topic.

According to Ethernet and the 802.3 standard, to be able to detect collisions, a transmitting station should monitor the network for a period of time called a *slot time*. Slot time is the time during which a collision may occur and is the maximum delay for a transmission to reach the far end of the network and for a collision to propagate back. Slot time is defined to be 51.2 microseconds (512 bit times in a 10-Mbps LAN). This time imposes a maximum length on the size of the network. It also imposes a minimum (64 bytes, excluding preamble and FCS) on the size of the frames transmitted by each station.

Frame Formats

The frame formats for Ethernet and IEEE 802.3 are not the same. However, both protocols use the same medium and access method. This means that, while LAN stations running these protocols could share a common bus, they could not communicate with each other.

Ethernet Frame Format

The layout of an Ethernet frame is as follows:

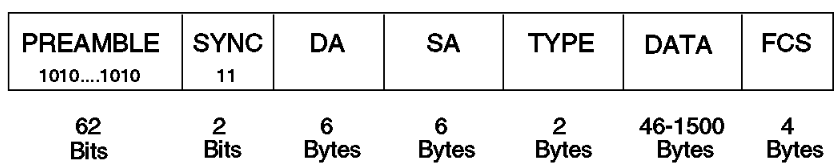


Figure 15. Ethernet Frame Format

- PREAMBLE - 62 bits, allows the Physical Layer Signalling (PLS) circuitry to synchronize with the receive frame timing circuitry.
- SYNC (Synchronize) - 2 bits, indicates that the data portion of the frame will follow.
- DA (Destination Address) and SA (Source Address) - 48-bits Media Access Control (MAC) address. Three types of destination addressing are supported:
  - Individual: The DA contains the unique address of one node on the network.
  - Multicast: If the first bit of the DA is set, it denotes that a *group* address is being used. The group that is being addressed will be determined by a higher layer function.

– Broadcast: When the DA field is set to all 1s, it indicates a *broadcast*. A broadcast is a special form of multicast. All nodes on the network must be capable of receiving a broadcast.

- TYPE (Type Field) - 16 bits long, this field identifies the higher layer protocol that is used. Vendors must register their protocols with the Ethernet standards body if they wish to use Ethernet Version 2.0 transport. Each registered protocol is given a unique 2-byte ***type*** identifier. As this field is used as the ***length*** field by the 802.3 frames, the value assigned to the type field in Ethernet is always higher than the maximum value in the length field for the 802.3. This is to ensure that both protocols can coexist on the same network.
- DATA - This contains the actual data being transmitted and is 46-1500 bytes in length. Ethernet assumes that the upper layers will ensure that the minimum data field size (46 bytes) is met prior to passing the data to the MAC layer. The existence of any padding character is unknown to the MAC layer.
- FCS - 32 bits long, the result of a cyclic redundancy check algorithm (specific polynomial executed against the contents of DA, SA, length, information and pad fields). This field is calculated by the transmitting station and is appended as the last four bytes of the frame. The same algorithm is used by the receiving station to perform the same calculation and the results are compared with the contents of the FCS field in the received frame to ensure that transmission was error free.

IEEE 802.3 Frame Format

The layout of the IEEE 802.3 frame format is as follows:

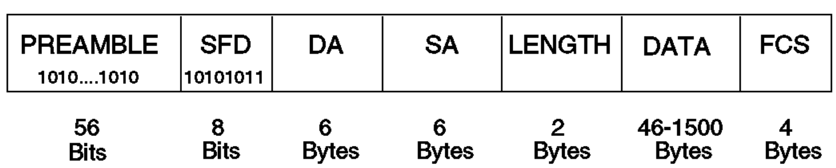


Figure 16. 802.3 Frame Format

- PREAMBLE - 56 bits long, allows the Physical Layer Signalling (PLS) circuitry to synchronize with the receive frame timing circuitry.
- SFD (Start Frame Delimiter) - 8 bits long, indicates that the data portion of the frame will follow.

- DA (Destination Address), SA (Source Address) - 48-bit Media Access Control (MAC) address. Three types of destination addressing are supported:
  - Individual - The DA contains the unique address of a node on the network.
  - Multicast - If the first bit of the DA is set, it denotes that a group address is being used. The group that is being addressed will be determined by a higher layer function.
  - Broadcast - When the DA field is set to all 1s, it indicates a *broadcast*. A broadcast is a special form of multicast. All nodes on the network must be capable of receiving a broadcast.
- LENGTH - 16 bits long, indicates the number of data bytes (excluding the PAD) that are in the data field.
- DATA and PAD field - IEEE 802.3 (and Ethernet) specify a minimum packet size (header plus data) of 64 bytes. However, 802.3 permits the data field to be less than the 46 bytes required to ensure that the whole packet meets this minimum. In order to ensure that the minimum packet size requirement is met, 802.3 requires the MAC layer to add *pad* characters to the LLC data field before sending the data over the network.
- FCS - 32 bits long, the results of a cyclic redundancy check algorithm (specific polynomial executed against the contents of DA, SA, length, information and pad fields). This field is calculated by the transmitting station and is appended as the last four bytes of the frame. The same algorithm is used by the receiving station to perform the same calculation and the results are compared with the contents of the FCS field in the received frame to ensure that transmission was error free.

List of Abbreviations

AB	area border
ACF	advanced communications function
ACF/VTAM	advanced communications function for the virtual telecommunications access method
ANR	automatic network routing
APPN	advanced peer-to-peer networking
ARB	adaptive rate-based flow/congestion control
ARC	active remote connector
ARP	address resolution protocol
AS	autonomous system
ASB	autonomous system border
ASE	autonomous system external
ASCII	american national standard code for information interchange
AUTO	automatic
BAN	boundary access node
BECN	backward explicit congestion notification
BER	box event record
BGP	border gateway protocol
BOOTP	bootstrap protocol
bps	bits per second
BRS	bandwidth reservation system
BSC	binary synchronous communication
C&SM	communications and system management
CBSP	control bus and service processor
CCITT	Comité Consultative International Télégraphique et Téléphonique The international telegraph and telephone consultative committee
CCU	central control unit
CD	carrier detector
CDF-E	configuration data file - extended
CE	customer engineer
CF3745	3745 and 3746 configurator and performance model
CHPID	channel path id
CIDR	classless inter-domain routing
CIR	committed information rate
CLIST	command list
CLA	communication line adapter
CLP	communication line processor
CM	communications manager
CNN	composite network node
CNM	communication network management
COS	cost of service
CP	control point
CR	communications rate
CSU	customer service unit
DCAF	distributed console access facility
DCE	data circuit-terminating equipment
DDS	digital data service
DE	discard eligibility
DLC	data link control
DLCI	data link connection identifier
DLSw	data link switching
DLUR	dependent LU requester
DLUS	dependent LU server
DMUX	double multiplex circuit
DSU	data service unit
DTE	data terminal equipment
DX	duplex
EBCDIC	extended binary-coded decimal interchange code
EBN	extended border node
EC	engineering change
EMIF	ESCON multiple image facility
EN	end node
EP	emulation program
EPO	emergency power OFF
ESCA	ESCON channel adapter
ESCC	ESCON channel coupler
ESCD	ESCON Director
ESCON	Enterprise Systems Connection
ESCP	ESCON processor
FC	feature code
FDX	full duplex
FECN	forward explicit congestion notification

FRAD	frame-relay access device
FRFH	frame-relay frame handler
FRSE	frame-relay switching equipment
FRTE	frame-relay terminating equipment
HCD	hardware configuration definition
HDX	half duplex
HI	high
HLA	host link address
HONE	hands-on network environment
HPR	high performance routing
HSS	high-speed scanner
ICMP	internet control message protocol
IML	initial microcode load
INN	intermediate network node or
	IBM information network
IOCP	Input/Output Configuration Program
IP	internet, or internetwork, protocol
IPL	initial program load
IPR	installation planning representative
ITU-T	international telecommunications union - telecommunications (ex-CCITT)
KB	kilobyte (processor storage) 1KB = 2^{10} bytes (1 024 bytes)
kbps	kilobits per second (speed or communication volume per second) 1 kbps = 1 000 (one thousand) bits per second
LAA	locally administered address
LAN	local area network
LCB	line connection box
LCBB	line connection box base
LCBE	line connection box expansion
LCP	link control protocol
LDM	limited distance modem
LED	light emitting diode
LIB n	line interface board type n
LIC n	line interface coupler type n
LSA	link state advertisement
LIU n	line interface coupler unit type n
LIV	link integrity verification
LMI	local management interface
LP	logical partition
LPDA®	link problem determination aid
LQ	line quality
LU	logical unit
LSS	low-speed scanner
MAC	medium access control
MAU	medium attachment unit
MB	megabyte (processor storage) 1MB = 2^{20} bytes (1 048 576 bytes)
Mbps	megabits per second (speed or communication volume per second) 1 Mbps = 1 000 000 (one million) bits per second
MCL	microcode change level
MES	miscellaneous equipment specification
MIB	management information base
MIH	missing interrupt handler
MLC	machine level control
MLTG	multi-link transmission group
MOSS-E	maintenance and operator subsystem - extended
MTP	multipoint
MUX	multiplex circuit
MVS	multiple virtual storage
NAU	network addressable unit
NMBA	nonbroadcast multiaccess
NCP	Network Control Program
NDRS	non-disruptive route switching
NGMF	netView graphic monitor facility
NN	network node
NNP	network node processor
NPM	netView performance monitor
NRZI	non-return-to-zero inverted
NVT	network virtual terminal
ODLC	outboard data link control
OSPF	open shortest path first
PBN	peripheral border node
PCI	Peripheral component interconnect
PEP	partitioned emulation program
PING	packet internet groper
PN	peripheral node
PPP	point-to-point protocol
PPPNCP	point-to-point network control protocol
PTP	point-to-point

PTT	post, telegraph, and telephone
PU	physical unit
PVC	permanent virtual circuit
QUAL	quality
RCV	receive clock
RETAIN®	remote technical assistance information network
RFS	ready for sending
RIP	routing information protocol
| **RNR**	receive not ready
ROS	read-only storage
| **RR**	receive ready
RSF	remote support facility
RTP	rapid transport protocol
RTS	request to send
SDLC	synchronous data link control
SMUX	single multiplex circuit
SNBU	switched network backup
SNI	SNA network interconnection
SNMP	simple network management protocol
SPAU	service processor access unit
SRC	service reference code
S/S	start-stop
SVC	switched virtual circuit
TC	test control
TCM	trellis code modulation
TCP	transmission control protocol
TG	transmission group
THRES	threshold
TICn	Token-ring interface coupler type n
TIM	time services
TOS	type of service
TPF	transaction processing facility
TRA	Token-ring adapter
TRP	Token-ring processor
TSS	transmission subsystem
UDP	user datagram protocol
UTP	unshielded twisted pair
VTAM	virtual telecommunications access method
XID	exchange station identification
XMIT	transmit

Glossary

This glossary defines new terms used in this manual.

adaptive rate-based flow and congestion control (ARB). A function of High Performance Routing (HPR) that regulates the flow of data over an RTP connection by adaptively changing the sender's rate based on feedback on the receiver's rate. It allows high link utilization and prevents congestion before it occurs, rather than recovering after congestion has occurred.

advanced communication function (ACF). A group of IBM licensed programs. principally VTAM programs. TCAM, NCP, and SSP, that use the concepts of Systems Network Architecture (SNA), including distribution of function and resource sharing.

advanced communications function for the virtual telecommunications access method (ACF/VTAM). An IBM licensed program that controls communication and the flow of data in an SNA network. It provides single-domain, multiple-domain, and interconnected network capability.

advanced peer-to-peer networking (APPN). Data communications support that routes data in a network between two or more advanced program-to-program communications (APPC) systems that do not need to be adjacent.

automatic network routing. A function of High Performance Routing (HPR) that is provides a low-level routing mechanism that requires no intermediate storage.

channel adapter (CA). A communication controller hardware unit used to attach the controller to a host processor.

communication controller. A device that directs the transmission of data over the data links of a network; its operation may be controlled by a program executed in a processor to which the controller is connected or it may be controlled by a program executed within the device. For example, the IBM 3745 and 3746 Network Nodes.

communications manager. A function of the OS/2 Extended Edition program that lets a workstation connect to a host computer and use the host resources as well as the resources of the other personal computers to which the workstation is attached, either directly or through a host system. The communications manager provides application programming interfaces (APIs) so that users and develop their own applications.

configuration data file - extended (CDF-E). A 3746 Network Node MOSS-E file that contains a description of all the hardware features (presence, type, address, and characteristics).

communications management configuration host node. The type 5 host processor in a communications management configuration that does all network-control functions in the network except for the control of devices channel-attached to a data host nodes. Synonymous with communications management host. See also data host node.

control panel. A panel that contains switches and indicators for the customer's operator and service personnel.

control program. A computer program designed to schedule and to supervise the execution of programs of the controller.

control subsystem. The part of the controller that stores and executes the control program, and monitors the data transfers over the channel and transmission interfaces.

customer engineer. See IBM service representative

data circuit-terminating equipment (DCE). The equipment installed at the user's premises that provides all the functions required to establish, maintain, and terminate a connection, and the signal conversion between the data terminal equipment (DTE) and the line. For example, a modem is a DCE.

Note: The DCE may be a stand-alone equipment or integrated in the 3745.

data terminal equipment (DTE). That part of a data station that serves as a data source, data link, or both, and provides for the data communication control function according to protocols. For example, the 3174 and PS/2s are DTEs.

data host node. In a communication management configuration, a type 5 host node that is dedicated to processing applications and does not control network resources, except for its channel adapter-attached or communication adapter-attached devices. Synonymous with data host. See also communications management configuration host node.

direct attachment. The attachment of a DTE to another DTE without a DCE.

ESCON channel. A channel having an Enterprise System Connection* channel-to-control-unit I/O interface that uses optical cables as a transmission medium.

ESCON channel adapter (ESCA). A communication controller hardware unit used to attach the controller to a host via ESCON fiber optics. An ESCA consists of an ESCON channel processor (ESCP) and an ESCON channel coupler (ESCC).

ESCON channel coupler (ESCC). A communication controller hardware unit which is the interface between the ESCON channel processor and the ESCON fiber optic cable.

ESCON channel processor (ESCP). A communication controller hardware unit which provides the channel data link control for the ESCON channel adapter.

distributed console access facility. (1) This program product provides a remote console function that allows a user at one programmable workstation (PS/2) to remotely control the keyboard input and monitor the display of output of another programmable workstation. The DCAF program does not affect the application programs that are running on the workstation that is being controlled. (2) An icon that represents the Distributed Console Access Facility.

enterprise systems chhnection (ESCON). A set of IBM products and services that provides a dynamically connected environment within an enterprise.

Host. See host processor

host processor. (1) A processor that controls all or part of a user application network. (2) In a network, the processing unit where the access method for the network resides. (3) In an SNA network, the processing unit that contains a system services control point (SSCP). (4) A processing unit that executes the access method for attached communication controllers.

High performance routing (HPR). An extension of APPN that provides faster traffic throughput, lower delays, and lower storage overheads.

IBM service representative. An individual in IBM who does maintenance services for IBM products or systems. Also called the IBM *Customer Engineer*.

initial microcode load (IML). The process of loading the microcode into an adapter, the MOSS, or the service processor.

internet. (1) A wide area network connecting disparate networks using the internetwork protocol (IP) (2) A public domain wide area network connecting thousands of disparate networks in industry, education, government and research. The Internet uses TCP/IP as the standard for transmitting information.

internet address. The numbering system used in IP internetwork communications to specify a particular network, or a particular host on that network with which to communicate.

internet control message protocol (ICMP). A protocol used by a gateway to communicate with a source host, for example, to report an error in a datagram. It is an integral part of the Internetwork Protocol (IP).

internetwork protocol. A protocol that routes data from its source to its destination in an internet environment. It is also called the *Internet Protocol*.

internetwork. Any wide area network connecting more than one network.

initial program load (IPL). The initialization procedure that causes the 3745 control program (NCP) to begin operation.

LAN-attached console. A PS/2 attached to the token-ring LAN that has the service processor attached. It is used to operate remotely the MOSS and MOSS-E functions.

IP router. A device that enables an Internetwork Protocol (IP) host to act as a gateway for routing data between separate networks.

line interface coupler (LIC). A circuit that attaches up to four transmission cables to the controller (from DTEs, DCEs or telecommunication lines).

locally administered address. In a local area network, an adapter address that the user can assign to override the universally administered address.

maintenance and operator subsystem - extended (MOSS-E). The licensed internal code loaded on the service processor hard disk to provide maintenance and operator facilities to the user and IBM service representative.

microcode. A program that is loaded in a processor (for example, the MOSS processor) to replace a hardware function. The microcode is not accessible to the customer.

modem (modulator-demodulator). See DCE.

multiple virtual storage (MVS). Multiple Virtual Storage, consisting of MVS/System Product Version 1 and the MVS/370 Data Facility Product operating on a System/370™ processor.

NetView. An IBM licensed program used to monitor a network, manage it, and diagnose its problems.

nonswitched line. A connection between systems or devices that does not have to be made by dialing. The connection can be point-to-point or multipoint. The line can be leased or private. Contrast with *switched line.*.

ping. A simple IP application that sends one or more messages to a specified destination host requesting a reply. Usually used to verify that the target host exists, or that its IP address is a valid address.

remote console. A PS/2 attached to the 3746 Network Node either by a switched line (with modems) or by one of the communication lines of the user network.

remote technical assistance information network (RETAIN).

service processor. The processor attached to a 3745, 3746-900, and 3746-950 via a token-ring LAN.

remote support facility (RSF). RSF provides IBM maintenance assistance when requested via the public switched network. It is connected to the IBM RETAIN database system.

service representative. See IBM service representative

services. A set of functions designed to simplify the maintenance of a device or system.

switched line. A transmission line with which the connections are established by dialing, only when data transmission is needed. The connection is point-to-point and uses a different transmission line each time it is established. Contrast with *nonswitched line*.

synchronous data link control (SDLC). A discipline for managing synchronous, code-transparent, serial-by-bit information transfer over a link connection. Transmission exchanges may be duplex or half-duplex over switched or nonswitched links. The configuration of the link connection may be point-to-point, multipoint, or loop. SDLC conforms to subsets of the Advanced Data Communication Control Procedures of the American National Standards Institute and High-Level Data Link Control (HDLC) of the International Standards Organization.

synchronous transmission. Data transmission in which the sending and receiving instruments are operating continuously at substantially the same frequency and are maintained, through correction, in a desired phase relationship.

Token-ring adapter (TRA) type 3. 3746-900 and 3746-950 line adapter for IBM Token-Ring Network, composed of one token-ring processor card (TRP2), and two Token-Ring interface couplers type 3 (TIC 3s).

Token-ring interface coupler type 2 (TIC2). A circuit that attaches an IBM Token-Ring network to the 3745.

Token-Ring Interface Coupler type 3 (TIC3). A circuit that attaches an IBM Token-Ring network to the 3746-900 or 3746-950.

user access area. A specific area in the controller where the customer can install, remove, change, or swap couplers and cables without IBM assistance.

universally administered address. In a local area network, the address permanently encoded in an adapter at the time of manufacture. All universally administered addresses are unique.

user application network. A configuration of data processing products, such as processors, controllers, and terminals, for data processing and information exchange. This configuration may use circuit-switched, packet-switched, and leased-circuit services provided by carriers or PTT. Also called a *user network*.

V.24, V.35, and X.21. ITU-T (ex-CCITT) recommendations on transmission interfaces.

Bibliography

Customer Documentation for the 3745 (All Models), and 3746 (Model 900)

Table 8 (Page 1 of 6). Customer Documentation for the 3745 Models X10 and X1A, and 3746 Model 900

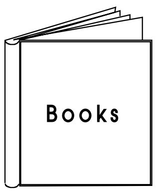
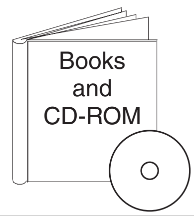
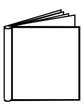
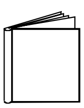
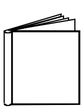
This customer documentation has the following formats:		
 		
Finding Information		
		3745 Models A and 3746 Books All of the books in the 3745 Models A and 3746 library are available on the CD-ROM that contains the Licensed Internal Code (LIC) for the machine.
Evaluating and Configuring		
	GA33-0092	***IBM 3745 Communication Controller Models 210, 310, 410, and 610*** ***Introduction*** Gives an introduction of the IBM Models 210 to 610 capabilities. For Models A, refer to the *Overview*, GA33-0180.
	GA33-0180	***IBM 3745 Communication Controller Models A and 170***[2] ***IBM 3746 Nways Multiprotocol Controller Models 900 and 950*** ***Overview*** Gives an overview of connectivity capabilities within SNA, APPN, and IP networking.
	GA27-4234	***IBM 3745 Communication Controller Models A***[2] ***IBM 3746 Nways Multiprotocol Controller Models 900 and 950*** ***Planning Series: Overview, Installation, and Integration*** Provides information for: • Overall 3746 planning • Installation and upgrade scenarios • Controller and service processor network integration • Related MOSS-E and CCM worksheets for these tasks.

Table 8 (Page 2 of 6). Customer Documentation for the 3745 Models X10 and X1A, and 3746 Model 900		
	GA27-4235	***IBM 3745 Communication Controller Models A***[2] ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***Serial Line Adapters*** Provides information for: • Serial line adapter descriptions • Serial line adapter line weights and connectivity • Types of SDLC support • Configuring X.25 lines • Performance tuning for frame-relay, PPP, X.25, and NCP lines. • ISDN adapter description and configuration.
	GA27-4236	***IBM 3745 Communication Controller Models A***[2] ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***Token Ring and Ethernet*** Provides information for: • Token-ring adapter description and configuration • Ethernet adapter desription and configuration.
	GA27-4237	***IBM 3745 Communication Controller Models A***[2] ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***ESCON Channels*** Provides information for: • ESCON adapter descriptions • ESCON configuration and tuning information • ESCON configuration examples.
	GA27-4238	***IBM 3745 Communication Controller Models A***[2] ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***Physical Planning*** Provides information for: • 3746 and MAE physical planning details • 3746 and MAE cable information • Explanation of installation sheets • 3746 plugging sheets.

Table 8 (Page 3 of 6). Customer Documentation for the 3745 Models X10 and X1A, and 3746 Model 900		
	GA27-4239	***IBM 3745 Communication Controller Models A[2]*** ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***Management Planning*** Provides information for: • Overview for 3746 • 3746 APPN/HPR, IP router, and X.25 • NetView Performance Monitor (NPM), remote consoles, and RSF • MAE APPN/HPR management.
	GA27-4240	***IBM 3745 Communication Controller Models A[2]*** ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***Multiaccess Enclosure Planning*** Provides information for: • MAE adapters details • MAE ESCON planning and configuration • ATM and ISDN support.
	GA27-4241	***IBM 3745 Communication Controller Models A[2]*** ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***Protocols Description*** Provides information for: • Overview and details about APPN/HPR and IP.
	On-line information	***IBM 3745 Communication Controller Models A[2]*** ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***Controller Configuration and Management Worksheets*** Provides planning worksheets for ESCON, Multiaccess Enclosure, serial line, and token-ring definitions.
Preparing Your Site		
	GC22-7064	***IBM System/360™, System/370™, 4300 Processor*** ***Input/Output Equipment Installation Manual-Physical Planning*** (Including Technical News Letter GN22-5490) Provides information for physical installation for the 3745 Models 130 to 610. For 3745 Models A and 3746 Model 900, refer to the *Planning Guide*, GA33-0457.
	GA33-0127	***IBM 3745 Communication Controller*** ***Models 210, 310, 410, and 610*** ***Preparing for Connection*** Helps for preparing the 3745 Models 210 to 610 cable installation. For 3745 Models A refer to the *Connection and Integration Guide*, SA33-0129.

Table 8 (Page 4 of 6). Customer Documentation for the 3745 Models X10 and X1A, and 3746 Model 900

Preparing for Operation	
GA33-0400	***IBM 3745 Communication Controller All Models[3] IBM 3746 Nways Multiprotocol Controller Models 900 and 950*** ***Safety Information[1]*** Provides general safety guidelines.
SA33-0129	***IBM 3745 Communication Controller All Models[3] IBM 3746 Nways Multiprotocol Controller Model 900*** ***Connection and Integration Guide[1]*** Contains information for connecting hardware and integrating network of the 3745 and 3746-900 after installation.
SA33-0416	***Line Interface Coupler Type 5 and Type 6 Portable Keypad Display*** ***Migration and Integration Guide*** Contains information for moving and testing LIC types 5 and 6.
SA33-0158	***IBM 3745 Communication Controller All Models[3] IBM 3746 Nways Multiprotocol Controller Model 900*** ***Console Setup Guide[1]*** Provides information for: • Installing local, alternate, or remote consoles for 3745 Models 130 to 610 • Configuring user workstations to remotely control the service processor for 3745 Models A and 3746 Model 900 using: – DCAF program – Telnet Client program – Java Console support.
Customizing Your Control Program	
SA33-0178	***Guide to Timed IPL and Rename Load Module*** Provides VTAM procedures for: • Scheduling an automatic reload of the 3745 • Getting 3745 load module changes transparent to the operations staff.
Operating and Testing	
SA33-0098	***IBM 3745 Communication Controller All Models[4]*** ***Basic Operations Guide[1]*** Provides instructions for daily routine operations on the 3745 Models 130 to 610.
SA33-0177	***IBM 3745 Communication Controller Models A[2] IBM 3746 Nways Multiprotocol Controller Model 900*** ***Basic Operations Guide[1]*** Provides instructions for daily routine operations on the 3745 Models 17A to 61A, and 3746 Model 900 operating as an SNA node (using NCP), APPN/HPR Network Node, and IP Router.

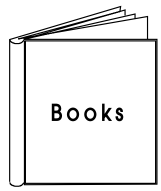
Table 8 (Page 5 of 6). Customer Documentation for the 3745 Models X10 and X1A, and 3746 Model 900		
	SA33-0097	***IBM 3745 Communication Controller All Models***[3] ***Advanced Operations Guide***[1] Provides instructions for advanced operations and testing, using the 3745 MOSS console.
	On-line Information	***Controller Configuration and Management Application*** Provides a graphical user interface for configuring and managing a 3746 APPN/HPR Network Node and IP Router, and its resources. It is also available as a stand-alone application, using an OS/2 workstation. Defines and explains all the 3746 Network Node and IP Router configuration parameters through its online help.
	SH11-3081	***IBM 3746 Nways Multiprotocol Controller Models 900 and 950*** ***Controller Configuration and Management: User's Guide***[5] Explains how to use CCM and gives examples of the configuration process.
	GA33-0479	***IBM 3745 Communication Controller Models A IBM 3746 Nways Multiprotocol Controller Models 900 and 950*** ***NetView Console APPN Command Reference Guide*** Explains how to use the RUN COMMAND from the NetView S/390 Program and gives examples.
Managing Problems		
	SA33-0096	***IBM 3745 Communication Controller All Models***[3] ***Problem Determination Guide***[1] A guide to perform problem determination on the 3745 Models 130 to 61A.
	On-line Information	***Problem Analysis Guide*** An online guide to analyze alarms, events, and control panel codes on: • IBM 3745 Communication Controller Models A[2] • IBM 3746 Nways Multiprotocol Controller Models 900 and 950.
	SA33-0175	***IBM 3745 Communication Controller Models A***[2] ***IBM 3746 Expansion Unit Model 900 IBM 3746 Nways Multiprotocol Controller Model 950*** ***Alert Reference Guide*** Provides information about events or errors reported by alerts for: • IBM 3745 Communication Controller Models A[2] • IBM 3746 Nways Multiprotocol Controller Models 900 and 950.

Table 8 (Page 6 of 6). Customer Documentation for the 3745 Models X10 and X1A, and 3746 Model 900

[1] Documentation shipped with the 3745.
[2] 3745 Models 17A to 61A.
[3] 3745 Models 130 to 61A.
[4] Except 3745 Models A.
[5] Documentation shipped with the 3746-900.

Additional Customer Documentation for the 3745 Models 130, 150, 160, 170, and 17A

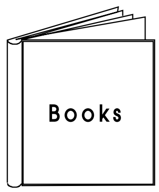
Table 9. Additional Customer Documentation for the 3745 Models 130 to 17A

This customer documentation has the following format:		
		
Finding Information		
		3745 Models A and 3746 Books All of the books in the 3745 Models A and 3746 library are available on the CD-ROM that contains the Licensed Internal Code (LIC) for the machine.
Evaluating and Configuring		
	GA33-0138	***IBM 3745 Communication Controller Models 130, 150, 160, and 170*** ***Introduction*** Gives an introduction about the IBM Models 130 to 170 capabilities, including Model 160. For Model 17A refer to the *Overview*, GA33-0180.
Preparing Your Site		
	GA33-0140	***IBM 3745 Communication Controller Models 130, 150, 160, and 170*** ***Preparing for Connection*** Helps for preparing the 3745 Models 130 to 170 cable installation. For 3745 Model 17A refer to the *Connection and Integration Guide*, SA33-0129.
[1] Documentation shipped with the 3745.		

Customer Documentation for the 3746 Model 950

Table 10 (Page 1 of 4). Customer Documentation for the 3746 Model 950

This customer documentation has the following formats:

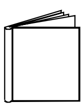


Finding Information

3745 Models A and 3746 Books

All of the books in the 3745 Models A and 3746 library are available on the CD-ROM that contains the Licensed Internal Code (LIC) for the machine.

Preparing for Operation



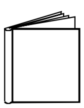
GA33-0400

IBM 3745 Communication Controller All Models[1]
IBM 3746 Expansion Unit Model 900
IBM 3746 Nways Multiprotocol Controller Model 950

Safety Information[2]

Provides general safety guidelines.

Evaluating and Configuring

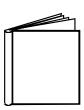


GA33-0180

IBM 3745 Communication Controller Models A and 170[3]
IBM 3746 Nways Multiprotocol Controller
Models 900 and 950

Overview

Gives an overview of connectivity capabilities within SNA, APPN, and IP networking.



GA27-4234

IBM 3745 Communication Controller Models A[2]
IBM 3746 Nways Multiprotocol Controller
Models 900 and 950

Planning Series:
Overview, Installation, and Integration

Provides information for:

- Overall 3746 planning
- Installation and upgrade scenarios
- Controller and service processor network integration
- Related MOSS-E and CCM worksheets for these tasks.

Table 10 (Page 2 of 4). Customer Documentation for the 3746 Model 950

GA27-4235	***IBM 3745 Communication Controller Models A*[2]** ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***Serial Line Adapters*** Provides information for: • Serial line adapter descriptions • Serial line adapter line weights and connectivity • Types of SDLC support • Configuring X.25 lines • Performance tuning for frame-relay, PPP, X.25, and NCP lines. • ISDN adapter description and configuration.
GA27-4236	***IBM 3745 Communication Controller Models A*[2]** ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***Token Ring and Ethernet*** Provides information for: • Token-ring adapter description and configuration • Ethernet adapter description and configuration.
GA27-4237	***IBM 3745 Communication Controller Models A*[2]** ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***ESCON Channels*** Provides information for: • ESCON adapter descriptions • ESCON configuration and tuning information • ESCON configuration examples.
GA27-4238	***IBM 3745 Communication Controller Models A*[2]** ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***Physical Planning*** Provides information for: • 3746 and MAE physical planning details • 3746 and MAE cable information • Explanation of installation sheets • 3746 plugging sheets.

Table 10 (Page 3 of 4). Customer Documentation for the 3746 Model 950

	GA27-4239	***IBM 3745 Communication Controller Models A[2]*** ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***Management Planning*** Provides information for: • Overview for 3746 • 3746 APPN/HPR, IP router, and X.25 • NetView Performance Monitor (NPM), remote consoles, and RSF • MAE APPN/HPR management.
	GA27-4240	***IBM 3745 Communication Controller Models A[2]*** ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***Multiaccess Enclosure Planning*** Provides information for: • MAE adapters details • MAE ESCON planning and configuration • ATM and ISDN support.
	GA27-4241	***IBM 3745 Communication Controller Models A[2]*** ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***Protocols Description*** Provides information for: • Overview and details about APPN/HPR and IP.
	On-line information	***IBM 3745 Communication Controller Models A[2]*** ***IBM 3746 Nways Multiprotocol Controller*** ***Models 900 and 950*** ***Planning Series:*** ***Controller Configuration and Management Worksheets*** Provides planning worksheets for ESCON, Multiaccess Enclosure, serial line, and token-ring definitions.

Table 10 (Page 4 of 4). Customer Documentation for the 3746 Model 950

Operating and Testing	
SA33-0356	***IBM 3746 Nways Multiprotocol Controller Model 950*** ***User's Guide***[2] Explains how to: • Carry out daily routine operations on Nways controller • Install, test, and customize the Nways controller after installation • Configure user's workstations to remotely control the service processor using: – DCAF program – Telnet client program – Java Console support.
On-line information	***Controller Configuration and Management Application*** Provides a graphical user interface for configuring and managing a 3746 APPN/HPR network node and IP Router, and its resources. It is also available as a stand-alone application, using an OS/2 workstation. Defines and explains all the 3746 Network Node and IP Router configuration parameters through its on-line help.
SH11-3081	***IBM 3746 Nways Multiprotocol Controller Models 900 and 950*** ***Controller Configuration and Management: User's Guide***[2] Explains how to use CCM and gives examples of the configuration process.
GA33-0479	***IBM 3745 Communication Controller Models A*** ***IBM 3746 Nways Multiprotocol Controller Models 900 and 950*** ***NetView Console*** ***APPN Command Reference Guide*** Explains how to use the RUN COMMAND from the NetView S/390 Program and gives examples.
Managing Problems	
On-line information	***Problem Analysis Guide*** An on-line guide to analyze alarms, events, and control panel codes on: • IBM 3745 Communication Controller Models A[3] • IBM 3746 Nways Multiprotocol Controller Models 900 and 950.
SA33-0175	***IBM 3745 Communication Controller Models A***[3] ***IBM 3746 Expansion Unit Model 900*** ***IBM 3746 Nways Multiprotocol Controller Model 950*** ***Alert Reference Guide*** Provides information about events or errors reported by alerts for: • IBM 3745 Communication Controller Models A[3] • IBM 3746 Nways Multiprotocol Controller Models 900 and 950.

[1] Models 130 to 61A.
[2] Documentation shipped with the 3746-950
[3] 3745 Models 17A to 61A.

Required Documentation

The following documents are indispensable for planning for your 3745/3746 controllers:

- *3745 Communication Controller Models A and 170, 3746 Nways Multiprotocol Controller Models 900 and 950: Overview*, GA33-0180
- *3745 Communication Controller All Models, 3746 Nways Multiprotocol Controller Model 900: Console Setup Guide*, SA33-0158.

Be sure to use the latest editions of the above documents.

Related Documentation

The following documents are also helpful for **planning** for your 3745/3746 controllers:

- *Planning for Integrated Networks*, SC31-8062
- *Planning and Reference for NetView, NCP, and VTAM*, SC31-7122.
- *Virtual Telecommunications Access Method V3 R4: Resource Definition Reference*, SC31-6438

The following Enterprise Systems Connection (**ESCON**) documents may be helpful:

- *Introducing the Enterprise Systems Connection*, GA23-0383
- *Enterprise Systems Connection Migration*, GA23-0383
- *Planning for Enterprise Systems Connection Links*, GA23-0367
- *Introducing Enterprise Systems Connection Directors*, GA23-0363.

The following *IBM International Technical Support Centers* “redbooks” are generally very helpful:

- *Frame Relay Guide*, GG24-4463
- *3746-900 and NCP Version 7 Release 2*, GG24-4464.

The following Network Control Program (**NCP**) documents may be helpful:

- For NCP V6 R2:
  - *Network Control Program V6 R2: Migration Guide*, SC31-6216
  - *Network Control Program V6 R2, ACF/SSP V3 R8, EP R11: Resource Definition Guide*, SC31-6209-01
  - *Network Control Program V6 R2, ACF/SSP V3 R8, EP R11: Resource Definition Reference*, SC31-6210-01
  - *Network Control Program V6 R2: Planning and Implementation Guide*, GG24-4012
  - *Network Control Program V6 R2, ACF/SSP V3 R8, EP R11: Library Directory*, SC31-6215.
- For NCP V6 R3:
  - *Network Control Program V6 R3: Migration Guide*, SC31-6217
  - *Network Control Program V6 R3, ACF/SSP V3 R9, EP R11: Resource Definition Guide*, SC31-6209-02
  - *Network Control Program V6 R3, ACF/SSP V3 R9, EP R11: Resource Definition Reference*, SC31-6210-02 Guide,
  - *Network Control Program V6 R3, ACF/SSP V3 R9, EP R11: Library Directory*, SC31-6218.
- For NCP V7 R1:
  - *Network Control Program V7 R1: Migration Guide*, SC31-6219
  - *Network Control Program V7 R1, ACF/SSP V4 R1, EP R12: Resource Definition Guide*, SC31-6223-00
  - *Network Control Program V7 R1, ACF/SSP V4 R1, EP R12: Resource Definition Reference*, SC31-6224-00
  - *Network Control Program V7 R1, ACF/SSP V4 R1, EP R12: Library Directory*, SC31-6220.

- For NCP V7 R2:
  - *Network Control Program V7 R2, ACF/SSP V4 R2, EP R12: Generation and Loading Guide*, SC31-6221.
  - *Network Control Program V7 R2: Migration Guide*, SC31-6258-00
  - *Network Control Program V7 R2, ACF/SSP V4 R2, EP R12: Resource Definition Guide*, SC31-6223-01
  - *Network Control Program V7 R2, ACF/SSP V4 R2, EP R12: Resource Definition Reference*, SC31-6224-01
  - *Network Control Program V7 R2, ACF/SSP V4 R2, EP R12: Library Directory*, SC31-6259.
- For NCP V7 R3:
  - *Network Control Program V7 R3: Migration Guide*, SC31-6258-01
  - *Network Control Program V7 R3, ACF/SSP V4 R3, EP R12: Resource Definition Guide*, SC31-6223-02
  - *Network Control Program V7 R3, ACF/SSP V4 R3, EP R12: Resource Definition Reference*, SC31-6224-02
  - *Network Control Program V7 R3, ACF/SSP V4 R3, EP R12: Library Directory*, SC31-6262.
- For NCP V7 R4:
  - *Network Control Program V7 R4: Migration Guide*, SC30-3786
  - *Network Control Program V7 R4, ACF/SSP V4 R4, EP R12: Resource Definition Guide*, SC31-6223-03
  - *Network Control Program V7 R4, ACF/SSP V4 R4, EP R12: Resource Definition Reference*, SC31-6224-03
  - *Network Control Program V7 R4, ACF/SSP V4 R4, EP R12: Library Directory*, SC30-3785.
- For NCP V7 R5:
  - *Network Control Program V7 R5: Migration Guide*, SC30-3833
  - *Network Control Program V7 R5, ACF/SSP V4 R4, EP R12: Resource Definition Guide*, SC31-6223-04
  - *Network Control Program V7 R5, ACF/SSP V4 R4, EP R12: Resource Definition Reference*, SC31-6224-04
  - *Network Control Program V7 R5, ACF/SSP V4 R4, EP R12: Library Directory*, SC30-3832.
- For NCP V7 R6:
  - *Network Control Program V7 R6: Migration Guide*, SC30-3833-01
  - *Network Control Program V7 R6, ACF/SSP V4 R4, EP R14: Resource Definition Guide*, SC31-6223-06
  - *Network Control Program V7 R6, ACF/SSP V4 R4, EP R14: Resource Definition Reference*, SC31-6224-06
  - *Network Control Program V7 R6, ACF/SSP V4 R4, EP R14: Library Directory*, SC30-3785.
- For NCP V7 R7:
  - *Network Control Program V7 R7: Migration Guide*, SC30-3889
  - *Network Control Program V7 R7, ACF/SSP V4 R4, EP R14: Resource Definition Guide*, SC31-6223-07
  - *Network Control Program V7 R7, ACF/SSP V4 R4, EP R14: Resource Definition Reference*, SC31-6224-07
  - *Network Control Program V7 R7, ACF/SSP V4 R4, EP R14: Library Directory*, SC30-3971.

The following **OS/2** document may be of some help:

IBM Extended Services® for OS/2 Programming Services and Advanced Problem Determination for Communications, SO4G-1007.

For the Distributed Console Access Facility (**DCAF**) Version 1.3 the following documents are needed:

- *DCAF: Installation and Configuration Guide*, SH19-4068
- *DCAF: User's Guide*, SH19-4069
- *DCAF: Target User's Guide*, SH19-6839.

To learn more about the **APPN** architecture, including high-performance routing (HPR), adaptive rate based flow and congestion control (ARB), dependent LU requesters/servers (DLURs/DLUSs), and other subjects, refer to:

- *Inside APPN - The Essential Guide to the Next-Generation SNA*, SG24-3669.
- *APPN Architecture and Protocol Implementations Tutorial* SG24-3669.

The following Virtual Telecommunications Access Method (**VTAM**), may be helpful:

- *Virtual Telecommunications Access Method V4R3: Resource Definition Reference*, SC31-6438.

For help with **TCP/IP**, refer to:

- *TCP/IP for MVS: Performance Tuning Guide*, SC31-7188.

To learn about token-ring configurations and the **IEEE 802.2** standard, refer to:

- *Token-Ring Network Architecture Reference*, SC30-3374.

These latest NetView documents may be helpful:

- *TME 10 NetView for OS/390 Version 1: Planning Guide*, GC31-8226
- *TME 10 NetView for OS/390 Version 1: Tuning Guide*, SC31-8240.

The following NetView Performance Monitor (**NPM**) documents are available:

- *NetView Performance Monitor: Concepts and Planning V2R2*, GH19-6961-01
- *NetView Performance Monitor: Concepts and Planning V2R3*, GH19-6961-02
- *NetView Performance Monitor: Concepts and Planning V2R4*, GH19-6961-03
- *NetView Performance Monitor: Concepts and Planning V3R1*, GH19-4221-00.

Index

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V

Y

Tell Us What You Think!

3745 Communication Controller Model A
3746 Nways Multiprotocol Controller
Models 900 and 950
Planning Series:

Token-Ring and Ethernet

Publication No. GA27-4236-01

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