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Systems

Introduction to the IBM 3704 and 3705 Communications Controllers

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IBM

Fourth Edition (July 1976)

This is a major revision of, and makes obsolete, GA27-3051-2 and Technical Newsletter GN27-3165. This edition contains several additions and changes as indicated on the Summary of Amendments page. Changes are periodically made to the information herein; before using this publication in connection with the operation of IBM systems, consult the latest IBM System/360 and System/370 Bibliography (GA22-6822) and associated Technical Newsletters, for the editions that are applicable and current.

Requests for copies of IBM publications should be made to your IBM representative or to the IBM branch office serving your locality.

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Preface

The IBM 3704 and 3705 Communications Controllers are compatible, programmed transmission control units designed to assume many teleprocessing control functions formerly assigned to a teleprocessing access method. The 3704 and the 3705 are controlled by a program resident in the controller.

This publication contains introductory information on the hardware components of the controllers and on the programs provided to support them. Any user or potential user of a 3704 or 3705—including management, programmers, operators, and maintenance personnel—should be familiar with the contents of this manual. The only prerequisite for this manual is an understanding of basic teleprocessing operations.

The manual is divided into eight chapters:

- General Concepts—This chapter gives an overview of the place of 3704 and 3705 communications controllers in the teleprocessing environment. It describes primarily the advantages that the controllers offer to the teleprocessing installation.
- Communications Controller Hardware Concepts—This chapter describes the functions of the 3704 and 3705 hardware components and features. It also indicates which features can be combined and, in general, the type of support each feature provides.
- The System Support Programs—This chapter covers the control-program generation procedure, the controller assembler, and the utilities. Primary emphasis is on the structure and use of the macro language for generating the control program.
- Network Control Program Concepts—This chapter summarizes the services (both standard and optional) provided by the various versions of the network control program.
- Emulation Program Concepts—This chapter summarizes the functions of the emulation program for the IBM 2701 Data Adapter Unit and the IBM 2702 and IBM 2703 Transmission Controls.
- Partitioned Emulation Programming Extension—This chapter explains how a network control program with the partitioned emulation programming (PEP) extension can concurrently perform network control functions for certain communication lines and emulation functions for others.
- The 3705-II and 3705 Enhancement Features—This chapter describes the 3705-II and the functions of the type 3 communication scanner, the type 4 channel adapter, monolithic (FET) storage, and line set enhancements. It also covers the programming support for these features.
- NCP Support for TCAM and VTAM Networks—This chapter describes the functions of the NCP in an SNA environment. It also describes 3705-II hardware enhancements.

The appendixes contain information on (1) the devices supported by the controllers in network control mode, (2) the types of stations supported by the controllers in emulation mode, (3) the capabilities of the line-attachment hardware for the controllers, and (4) the publications relating to the 3704 and 3705 controllers.

In this manual, the term *controller* is used when the discussion applies to both the 3704 and the 3705. A *teleprocessing subsystem*, as referred to in this publication, includes remote stations, modems (data sets), communication lines, and the communications controller. The *teleprocessing network* consists of either: (1) one or more stations and the communication lines that connect them to the controller and host or (2) in SNA terms, the combination of two or more single-host networks into one large multiple-host network. The term *station* refers to the teleprocessing equipment at the remote end of a commu-

nication line. A station may include one or several teleprocessing units. A *teleprocessing unit* is a single piece of equipment that communicates with a computer from a remote location over a communication line. It can be a terminal, a terminal component, a control unit, or another computer.

As used throughout this publication, the term *communication line*, or simply *line*, refers to the path over which information is transmitted from one point in a teleprocessing network to another. The path may in actuality be any communication facility of the communications common carrier, such as wire or radio; or it may be a combination of facilities.

There are three versions of the network control program. In this publication, *network control program* refers to any version; NCP 1, NCP 2, and NCP 5 refer to the respective versions.

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Related Publications

These publications about the IBM 3704 and 3705 are now available:

IBM 3704 and 3705 Communications Controllers:

Principles of Operation (GC30-3004)

Emulation Program Generation and Utilities Guide and Reference Manual (GC30-3002)

Emulation Program Storage and Performance Reference Manual (GC30-3005)

Assembler Language (GC30-3003)

Emulation Program, Program Logic Manual (SY30-3001)

Network Control Program/VS Generation and Utilities Guide and Reference Manual (GC30-3007)

Network Control Program, Program Logic Manual (SY30-3003)

Network Control Program/VS, Program Logic Manual (SY30-3007)

IBM 3704 and 3705 Control Program Generation and Utilities Guide and Reference Manual (GC30-3000)

Storage Estimates and Performance Planning for the IBM 3704 and 3705 Communications Controllers Network Control Program (GC30-3006)

IBM 3704 and 3705 Program Reference Handbook (GY30-3012)

Network Control Program/TCAM Network User's Guide (GC30-3009)

Guide to Using the IBM 3704 Communications Controller Control Panel (GA27-3086)

Guide to Using the IBM 3705 Communications Controller Control Panel (GA27-3087)

IBM 3704 Operator Reference Summary (GA27-3091)

IBM 3705 Operator Reference Summary (GA27-3092)

IBM System/360 Installation Manual—Physical Planning (GC22-6820)

IBM System/370 Installation-Manual—Physical Planning (GC22-7004)

Appendix D summarizes the contents of each of these manuals. Ask your IBM representative about the current availability of publications about the 3704 and 3705 communications controllers.

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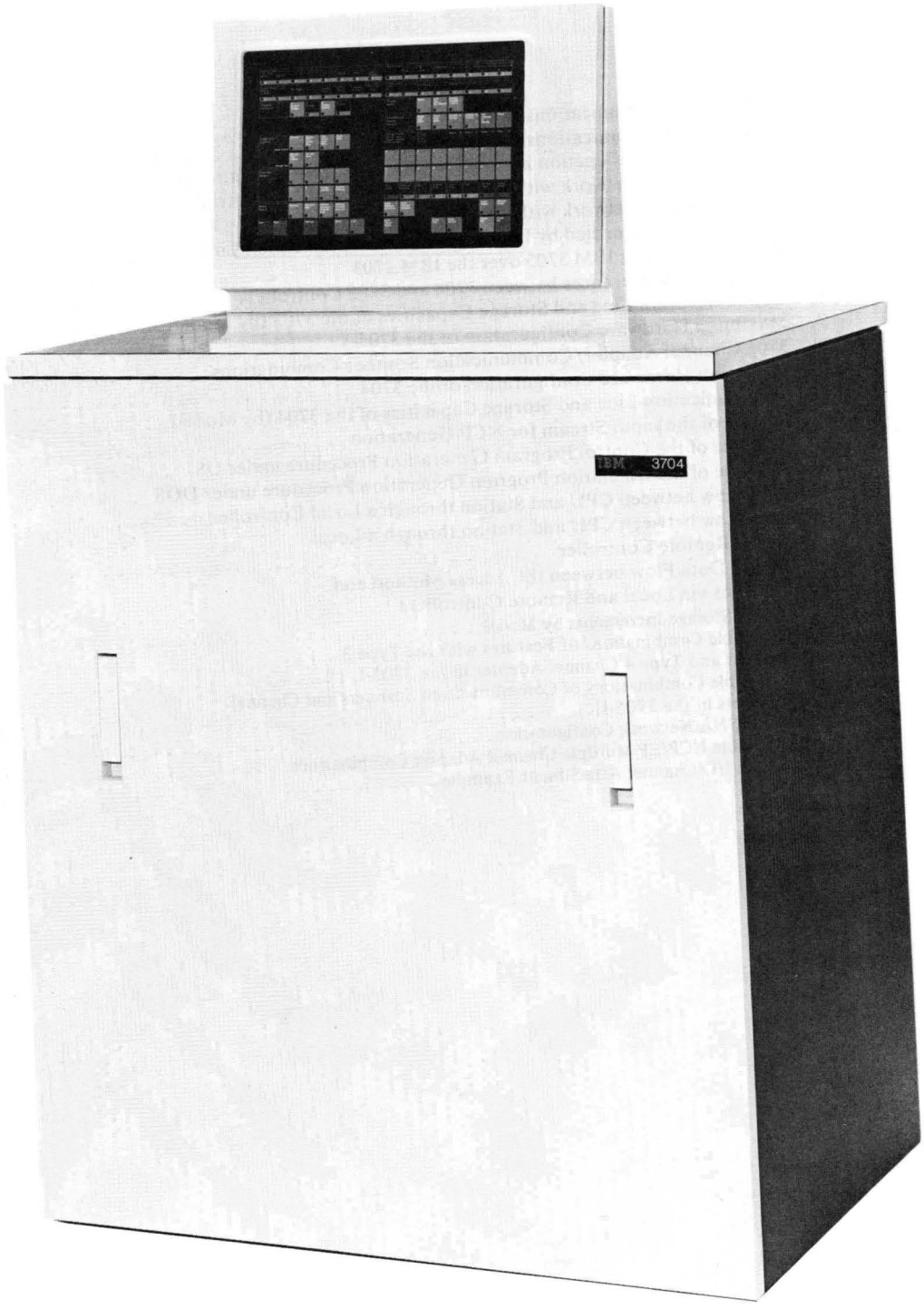
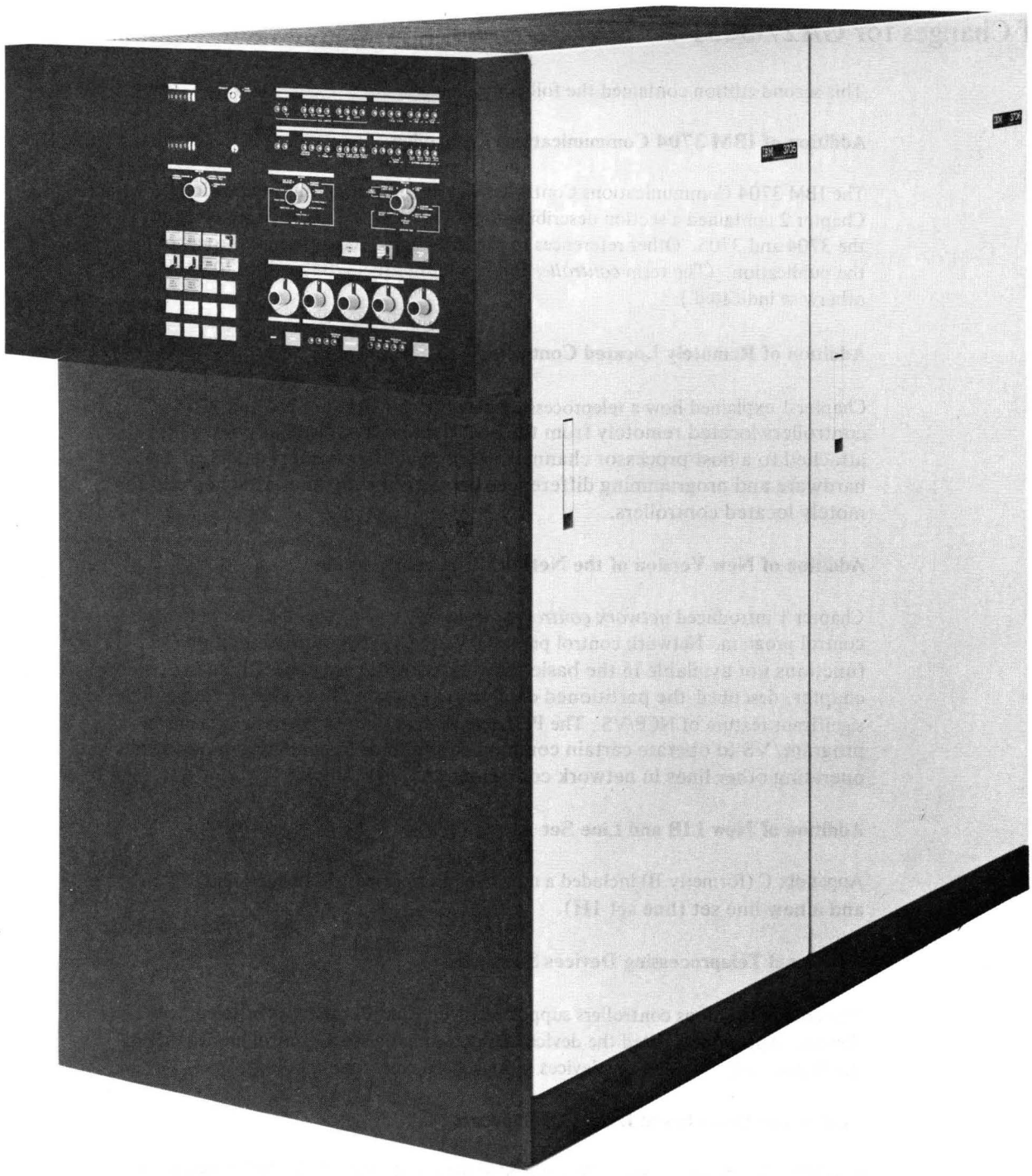


IBM 3704 Communications Controller



IBM 3705 Communications Controller—B-Model

Summary of Changes for GA27-3051-1

This second edition contained the following changes.

Addition of IBM 3704 Communications Controller

The IBM 3704 Communications Controller was introduced in this publication. Chapter 2 contained a section describing the 3704 hardware and a figure comparing the 3704 and 3705. Other references to the 3704 and 3705 appeared throughout the publication. (The term *controller* refers to either the 3704 or the 3705 unless otherwise indicated.)

Addition of Remotely Located Controllers

Chapter 1 explained how a teleprocessing network can include 3704 and 3705 controllers located remotely from the host processor, as well as controllers attached to a host processor channel. The remaining chapters described the hardware and programming differences between the channel-attached and remotely located controllers.

Addition of New Version of the Network Control Program

Chapter 1 introduced *network control program/VS,* a new version of the network control program. Network control program/VS (NCP/VS) provided additional functions not available in the basic network control program. Chapter 6, a new chapter, described the partitioned emulation programming (PEP) extension, a significant feature of NCP/VS. The PEP extension permitted the network control program/VS to operate certain communication lines in emulation mode while operating other lines in network control mode.

Addition of New LIB and Line Set

Appendix C (formerly B) included a new line interface base (LIB type A1) and a new line set (line set 1H).

Additional Teleprocessing Devices Supported

The communications controllers supported several additional types of teleprocessing devices. Appendix A listed the devices supported in network control mode. Appendix B (formerly D) listed the devices supported in emulation mode.

Addition of OS/VS and DOS/VS Support

OS/VS (Operating System/Virtual Storage) and DOS/VS (Disk Operating System/Virtual Storage) were added to the operating systems under which the system support programs for the controllers can run.

Two access methods, OS/VS VTAM and DOS/VS VTAM (Virtual Telecommunications Access Method) were provided for communication with the network control program/VS.

Alternate Path Retry Renamed

The program facility referred to in the previous edition as *alternate path retry* was changed to *switched network backup.*

Program Generation Procedure Clarified

Chapter 3 distinguished the OS and DOS program generation procedures.

Line Set Interface Information Removed

Information on line set to modem/auto call unit interfaces (formerly Appendix C) was moved to the *Original Equipment Manufacturers' Information* publication (GA27-3053).

Addition of List of Publications

A list of publications related to the 3704 and 3705 controllers appeared as Appendix D.

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Other minor clarifications and corrections appeared in this edition.

See your IBM representative for information about the availability of the new devices, program version, and features mentioned in this summary.

Summary of Changes for GA27-3051-2

The third edition contained the following changes.

Program and Hardware Changes

The following changes to the manual were the result of changes to the program or hardware support for the communications controllers.

New Versions of the Network Control Program

The functions of two new versions of the network control program—NCP 3 and NCP 4—were described in Chapter 1 and Chapter 4 of this edition. These versions were designed for operation with the OS/VS VTAM and DOS/VS VTAM access methods. Their outstanding feature was support of stations that use the SDLC line control.

New Station Types Supported

Several new types of stations were supported by the new versions of the network control program. These stations appeared in the list in Appendix A.

NCP Support for Remote Controllers Changed

Remote communications controllers were supported in NCP 3 and NCP 4 only. Changes were made throughout the manual to reflect this new support.

Manual Changes

The following changes were made to correct errors or to enhance the manual in some way. They did not reflect changes to the product.

Terminology Changes

- The term *local* was used instead of *primary* when referring to a controller attached to the host processor by a CPU channel. Likewise, *local network control program* replaced the term *primary network control program* when referring to the program that resides in such a controller.
- The term *remote* was used instead of *secondary* when referring to a controller that is located at some distance from the host processor. Likewise, *remote network control program* replaced the term *secondary network control program* when referring to the program that resides in such a controller.
- *Local/remote communication link* was used to refer to the communication line that links a local and a remote controller. The term used in the previous edition was *trunk line.*
- The version of the network control program formerly called the *basic network control program* was referred to as the *network control program, version 1,* or *NCP 1.*
- The version of the network control program formerly called the *network control program/VS* was referred to as the *network control program, version 2,* or *NCP 2.*

Clocking Requirements for LIBs and Line Sets Added

Appendix C contained a list indicating for each line set (or line interface base) whether it requires modem or business machine clocking.

Sections of Chapter 4 Deleted

The sections on network control program commands and on sessions, formerly in Chapter 4, were deleted from this manual. Information that was in these sections was moved to other publications. See Appendix D for descriptions of these manuals.

Appendix D Revised

Appendix D included more extensive descriptions of the manuals currently available for the 3704 and 3705. A chart at the beginning of the appendix indicated how each type of manual might be used.

TNLs Incorporated

The following Technical Newsletters were incorporated into this revision.

- GN27-3120—This TNL added descriptions of several new LIBs and line sets for the 3704 and 3705. It also added some new types of stations supported by the network control program.
- GN27-3122—This TNL added information about the type 3 channel adapter for the 3705.
- GN27-3136—This TNL described expanded LIB support for a 3704 with the type 2 communication scanner. It also included updated information on some of the LIBs and line sets.

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Other minor clarifications and corrections appeared in this edition.

Summary of Changes for GA27-3051-3

The fourth edition contains the following changes.

Program Product Version of the Network Control Program

The program product version of the network control program, which supports systems network architecture (SNA) networking, is described in Chapter 8 of this edition. The outstanding feature of this version is its support of interconnection of two or more single-host networks to share resources and reduce costs.

3705-II Hardware Enhancements

Also included in Chapter 8 of this edition are descriptions of the following enhancements of the 3705-II hardware:

- Type 4 channel adapter improvements
- 3705-II remote capability
- Duplex wideband line sets

Manual Changes

TNL GN27-3165 has been incorporated into this revision. That TNL contained information about the 3705-II and four new features.

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Other minor clarifications and corrections appear in this edition.

Chapter 1: General Concepts

Teleprocessing is a growing part of the data processing industry, and teleprocessing operations must be flexible to accommodate the increasing diversity of teleprocessing products, communication facilities, transmission control units, and other teleprocessing equipment. In addition, the extremely time-dependent teleprocessing functions put great demands on all the resources of the data processing system. These demands increase as the teleprocessing subsystem grows.

The IBM 3704 and 3705 Communications Controllers are compatible, programmed transmission control units designed to assume many of the line-control and processing functions for the teleprocessing subsystem. In many installations, primary control of the teleprocessing network is concentrated in the central processing unit (CPU), with a teleprocessing access method controlling the flow of data to and from the stations in the network. Sending and receiving data over the communication lines is a function of the transmission control unit, operating in response to commands from the access method. In addition to performing the usual functions of transmission control units, the communications controllers take over many of the functions of an access method. In this way, the controllers remove much of the control of the teleprocessing subsystem from the CPU. Figure 1 illustrates this centralization of function.

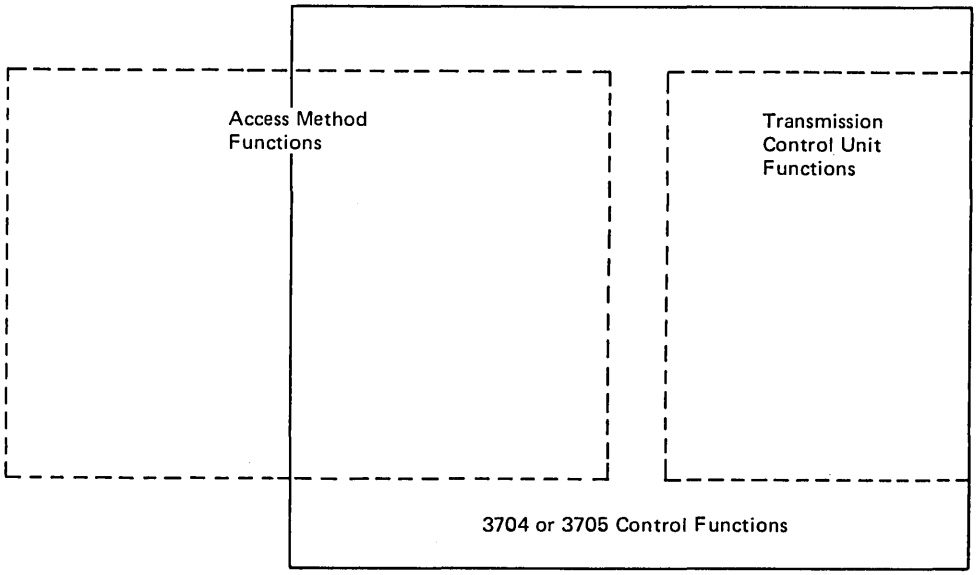


Figure 1. Centralization of Function in the IBM Communications Controllers

Network Configuration with the Communications Controllers

The 3704 and 3705 controllers, though dissimilar in appearance, serve precisely the same purpose in a teleprocessing network. The control programs provided have identical capabilities. The essential difference between the two controllers is the size of the networks they can accommodate. Figure 5 in Chapter 2 summarizes the differences between the controllers in number of communication lines, maximum line speeds, and storage capacity available. (As used throughout this publication, the term *communication line*, or simply *line*, refers to the path over which information is transmitted from one point in a teleprocessing network to another. The path may in actuality be any communication facility of the communications common carrier, such as wire or radio; or it may be a combination of facilities.)

The control program in the communications controller communicates with a teleprocessing access method in the CPU to which the controller is connected. This CPU is called the *host processor.*

A controller may be attached directly to a host processor channel via a channel adapter, or it may be located many miles distant from the host processor. Figure 2 shows a teleprocessing network in which all stations are directly connected to a single controller attached to a host processor channel. Figure 3 shows a network in which the stations more distant from the host processor are connected to a separate controller. In the latter arrangement, the controller attached to the host processor channel is called the *local controller*, and the distant controller is called the *remote controller.* Using remote controllers in a teleprocessing network allows the controller to be placed nearer the stations it serves, thus reducing the aggregate length of the communication lines. This reduction in line mileage can significantly lessen line charges—a major portion of network cost—even though two controllers and a relatively expensive communication line between them are required.

A remote controller must be linked to a local controller by a duplex or half-duplex communication line. This line, called the *local/remote communication link*, carries all the message traffic exchanged between the host processor and stations connected to the remote controller. (In this publication, the term *duplex communication line* means a line having two independent data paths over which data can be transmitted simultaneously in both directions; a *half-duplex communication line* is one having a single data path over which data can be transmitted in either direction, but not simultaneously. A duplex communication line may operate in half-duplex mode.)

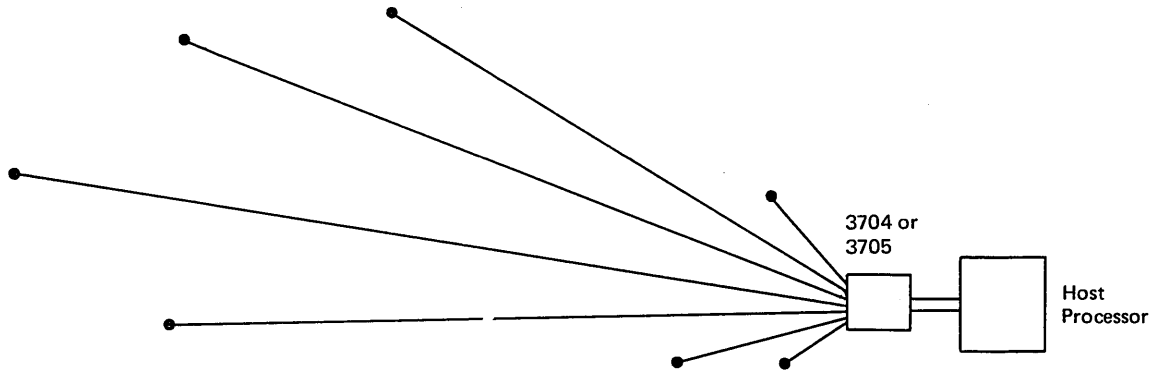


Figure 2. Teleprocessing Network with a Single Communications Controller

Only one communication link may exist between a local and a remote controller. However, if this link fails, the controllers may be connected via the switched communication network (with half-duplex data transfer) provided that they have the required hardware and program options.

Although Figure 3 shows only one remote controller, multiple remote controllers may be connected to the same local controller, each by a separate local/remote communication link. (A remote controller cannot be connected to more than one local controller.)

The 3705 is designed for either (1) attachment to an IBM System/360 byte-multiplexer channel or to an IBM System/370 selector, byte-multiplexer, or block-multiplexer channel; or (2) communication over a duplex or half-duplex local/remote communication link with a local, channel-attached 3704 or 3705. The 3704 is designed for either (1) attachment to a System/360 or System/370 byte-multiplexer channel; or (2) communication over a duplex or half-duplex local/remote communication link with a local, channel-attached 3704 or 3705.

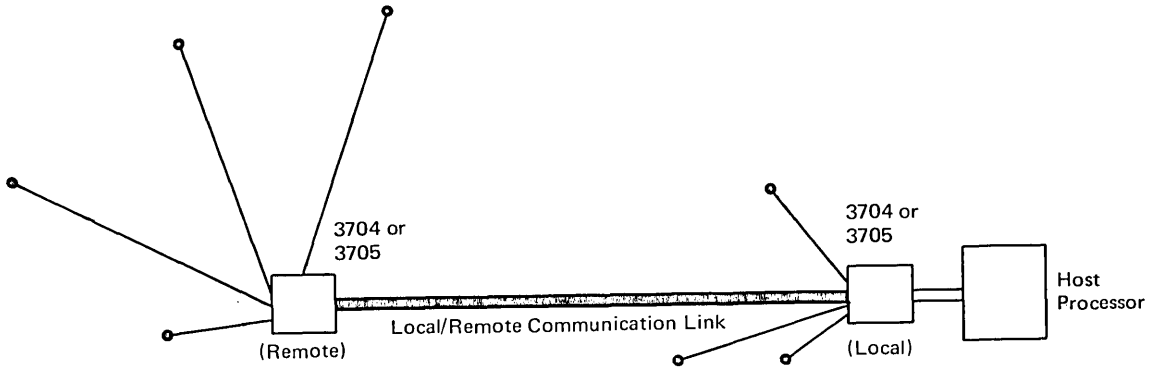


Figure 3. Teleprocessing Network with Two Communications Controllers Connected by Local/Remote Communication Link

Program Support for the Controllers

Network Control Program: Much of the increased capability of the controllers is provided by the *network control program* (NCP), which is executed in the controller. The network control program provides the flexibility necessary to meet increasing teleprocessing demands and at the same time relieves the CPU of much of the teleprocessing responsibility.

Three versions of the network control program are provided. The network control program, version 1, referred to as NCP 1, handles much of the logical and physical control of the teleprocessing network, taking over functions that are often performed by an access method or by a transmission control unit. The second version, called the network control program/VS, version 2 (NCP 2) provides added functions—principally, the partitioned emulation programming extension (discussed below).

The network control program/VS, version 5 (NCP 5) supports remote communications controllers, and allows communication via synchronous data link control (SDLC) with certain clusters, such as the IBM 3600 Finance Communication System. It also adds the following capabilities:

- Communication with certain terminals (as well as clusters) via SDLC.
- SDLC communication over the switched communication network.
- Support of terminals and clusters using SDLC communication by a remote controller.

The functions of all versions of the network control program are described in detail in Chapter 4. Information on SDLC is in the publication, *IBM Synchronous Data Link Control General Information* (GA27-3093).

The network control program must communicate with a teleprocessing access method in the host processor. IBM provides the OS Telecommunications Access Method (TCAM) for communicating with NCP 1, the first version of the network control program. For NCP 2, IBM provides the OS/VS TCAM access method. IBM provides the OS/VS TCAM, OS/VS VTAM, and DOS/VS VTAM access methods for support of NCP 5.

The specific features offered by TCAM for communicating with a network control program are described in the publications, *OS TCAM Programmer's Guide* (GC30-2024) and *OS/VS TCAM Programmer's Guide* (GC30-2034). Similar information for VTAM is given in *Introduction to VTAM* (GC27-6987).

Emulation Program: IBM also provides an *emulation program* (EP) to run in controllers attached to a host processor channel. This program emulates the functional operation of the IBM 2701 Data Adapter Unit, the IBM 2702 Transmission Control, and the IBM 2703 Transmission Control, and allows many programs written for operation with the 2701, 2702, and 2703 to operate with the controllers without modification.

The emulation program can communicate with access methods running in a System/360 or System/370. Chapter 5 describes the emulation program in more detail.

Partitioned Emulation Programming Extension: A feature of the network control program, versions 2 and 5, called the *partitioned emulation programming* (PEP) extension, allows the program to operate some communication lines in network control mode while operating others in emulation mode. An NCP with PEP can be executed only in a local controller. The program communicates with one or more teleprocessing access methods in the System/370 host processor. Chapter 6 contains additional information about the partitioned emulation programming extension.

System Support Programs: In addition to the network control and emulation programs, IBM provides *system support programs.* These programs, which are executed in a central processing unit, generate control programs, load them into controller storage, and dump controller storage. Chapter 3 specifies the operating systems under which the support programs run and describes their functions.

The *NCP Generation and Utilities* and *EP Generation and Utilities* manuals provide information on defining network control programs and emulation programs, and on using the support programs. See Appendix D for descriptions of these manuals.

A Compatible Family

The various models of the 3704 and the 3705 make up a compatible family of communications controllers that provides a teleprocessing entry for every type of installation, from the completely new user to the large user with an existing network. The controllers offer an easy path for conversion from existing systems and for continuing teleprocessing growth.

The 3704 is designed primarily for new teleprocessing installations and small installations that presently have a few lines attached through IBM 2701 or IBM 2702 or equivalent control units. The emulation program eases the transition from the 2701 and 2702 to the 3704.

The 3705 is designed for teleprocessing installations with large networks that require one or more IBM 2701, IBM 2702, or IBM 2703, or equivalent, control units. In addition, the 3705 offers the smaller user a convenient means of increasing the size of his network. The emulation program and the network control program with PEP allow easy conversion from the 2701, 2702, and 2703 to the 3705.

Figure 5 in Chapter 2 summarizes the differences between the 3704 and 3705 controllers in number of communication lines supported, maximum line speeds, and storage capacity available.

Transition from a 3704 to a 3705 is eased by the compatibility of the IBM-supplied programming support for the two machines. A network control program for either the 3704 or the 3705 can be generated from the same library of network control program modules; the same macro language is used. The same is true for the emulation program; only one library of emulation program modules is required for both machines. A control program generated for the 3704 could be executed by a 3705 with the same configuration of communication lines and adapter hardware, provided the amount of storage installed is adequate. Conversely, a program generated for the 3705 could be executed by a 3704, if both are equipped with the same types of scanners and channel adapters, and both have sufficient storage. The support programs for the network control and emulation programs are identical for the 3704 and the 3705. Likewise, an access method that communicates with the 3704 will communicate with an identically configured 3705.

Advantages of the IBM Communications Controllers

The IBM 3704 and 3705 Communications Controllers have most of the capabilities and features of the IBM 2701 Data Adapter Unit, the IBM 2702 Transmission Control, and the IBM 2703 Transmission Control. With the additional capabilities provided by the network control program and new features in the design of the hardware, the controllers offer many advantages over these transmission control units.

In the following discussion, the largest of the transmission control units mentioned above, the IBM 2703, is used for comparison to the 3705. Figure 4 illustrates some of the advantages that the 3705 with the network control program has over the 2703. These advantages prevail whether the 3705 is a local or a remote controller. The 3704 with the network control program has equivalent advantages over the IBM 2701 and 2702.

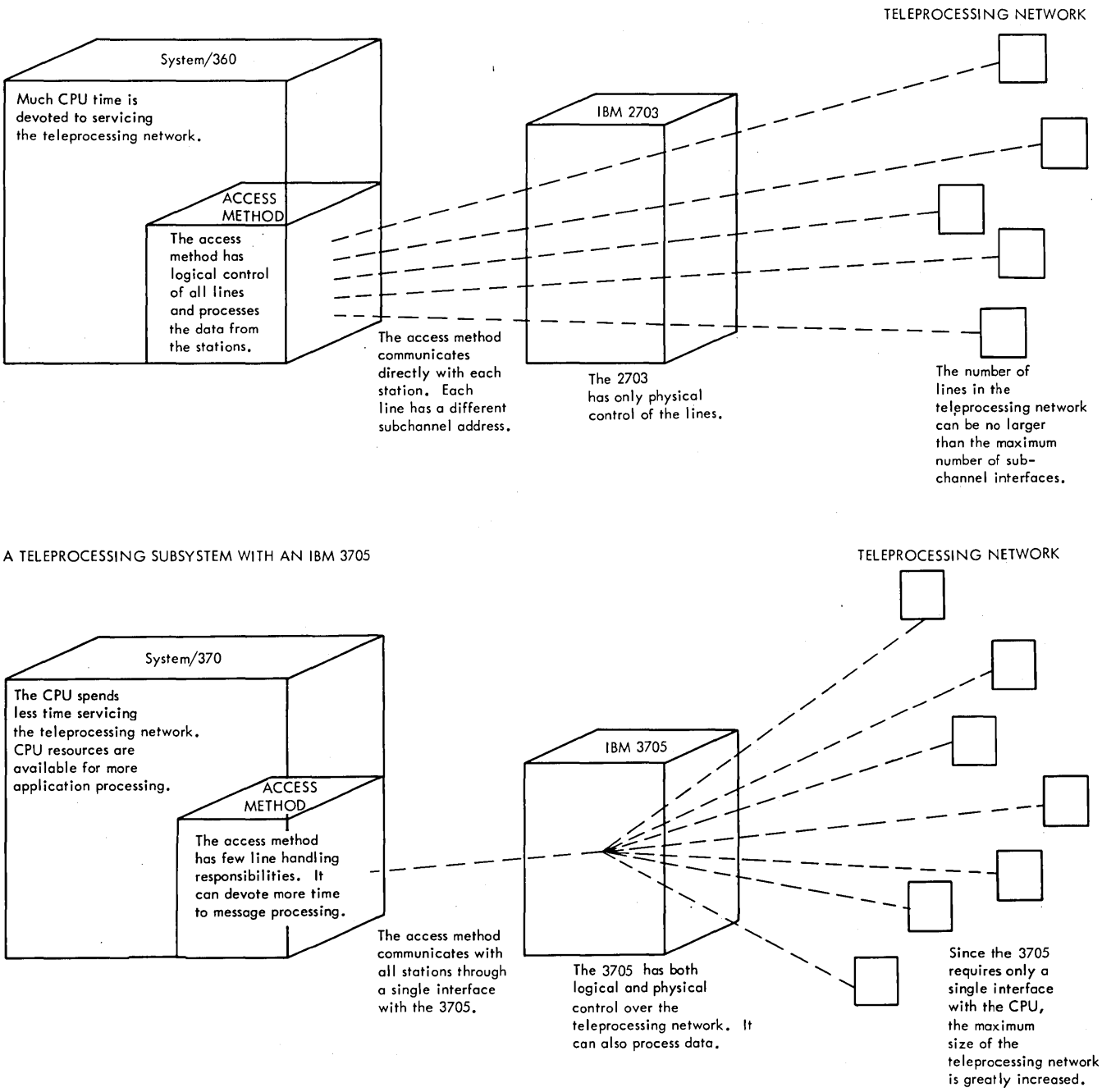


Figure 4. Advantages of the IBM 3705 over the IBM 2703

The Controllers Are Flexible

Flexibility is one of the principal advantages of the 3704 and 3705 controllers. Both the hardware and the network control program are designed to allow a high degree of flexibility in configuring the teleprocessing subsystem to meet the particular requirements of most installations.

The 3704 and 3705 can communicate with many types of teleprocessing stations using both synchronous and asynchronous line-control disciplines at line speeds from 45.5 bps to 50,000 bps. For a list of the stations supported, see Appendixes

A and B. The network control program recognizes and translates a variety of transmission codes, including USASCII, EBCDIC, EBCD, BCD, and Correspondence Code.

A maximum of 32 communication lines for half-duplex operation can be attached to the 3704. A maximum of 352 lines for half-duplex operation can be attached to the largest model of the 3705 (twice as many as for the 2703). These limits include any local/remote communication links. Each duplex local/remote communication link decreases by two and each half-duplex local/remote communication link decreases by one the number of communication lines available for communicating with stations in the network in half-duplex mode. The actual number of communication lines that the controllers can support depends upon performance factors and the combination of features chosen.

In addition, the line-attachment hardware provided for the controllers allows many different types of communication lines to be attached through a single line scanner. Lines are available in pairs (and in some cases, singly) rather than in groups of four or eight, as in the 2703. This characteristic allows considerable latitude in the number of line types that can be attached to the controllers. This is especially advantageous when an installation requires a few lines of several different types. In many cases, such a network requires only a minimum of line-attachment hardware.

The 3705 hardware offers additional flexibility in the choice of channel adapters and line scanners (called *communication scanners* in the controllers). Depending upon the anticipated throughput and type of system attachment desired, you can choose between three types of channel adapters (for a local controller only) and two types of communication scanners. One type of scanner and two types of channel adapters offer high throughput and performance capabilities. The other type of each one, which costs less but can handle less throughput, is suitable for use with smaller networks. The 3704 is available with the same two types of communication scanners as the 3705, but it offers only the low-throughput channel adapter.

Further contributing to the flexibility of the 3704 and 3705 controllers is the network control program, which you can easily adapt to the requirements of your teleprocessing installation. The standard network control program functions include a wide range of facilities to control the teleprocessing subsystem. In addition, a number of optional functions can be performed by the network control program or by the access method, or, in some cases, omitted entirely.

You describe the network control program that meets the requirements of your installation by using a high-level macro language. This language gives you control over many of the operating characteristics of the teleprocessing subsystem. You control some characteristics by specifying particular values for certain network control program parameters or specific functions to be included in or excluded from the program. You control other characteristics indirectly, depending on the network and the options you specify. For example, you need not specify the order in which communication lines are scanned for service requests. The scanning scheme is determined internally by the network control program generation procedure using a combination of factors that you specify in describing the network.

Since the scanning mechanism is program-controlled, the controller's scanning hardware need not be rewired for every change in network configuration. When

new communication lines are added to the network, any modifications to the scanning scheme are made automatically when the network control program is regenerated to include the new lines.

This characteristic also permits the generation of several different network control programs to handle different subsets of communication lines, all attached to the same controller. The program currently resident in the controller determines which lines are scanned and in which order, depending upon the parameters specified when that program was generated.

Flexibility in the network control program is increased by the ability to change certain network characteristics dynamically, that is, during execution of the program. The access method can issue special commands to the program to make changes such as activating and deactivating communication lines. This allows you to modify the teleprocessing subsystem as the demands of the network change.

A principal advantage of a network control program with the partitioned emulation programming (PEP) extension is the ability to operate the same communication line alternately in network control mode and emulation mode. Changes from one mode to the other are made during program execution, by command from the access method. Alternate operation requires that the stations connected to the line be supported in both network control mode and emulation mode. (Appendixes A and B list the types of stations supported in each mode.) In addition, you must specify, during program generation, that the line is to be operable in either mode.

The Controllers Are Modular in Design

Much of the flexibility of the controllers comes from the modular design of the hardware and the network control program. Such modularity allows the controllers to grow easily to meet the needs of an expanding teleprocessing subsystem.

Both the 3704 and the 3705 offer storage in increments that can be ordered according to the needs of the particular installation. They also offer a wide range of choices in line-attachment hardware.

The controller is available in models—four for the 3704 and twenty for the 3705—that allow easy expansion of the teleprocessing network. The various models of the 3705 also offer options in the number of channel adapters (for local controllers only) and communication scanners you can order, in addition to the amount of storage and line-attachment hardware.

Also, the network control program is designed in modules that are selected according to the requirements of the network. Since no teleprocessing subsystem requires all the facilities of the network control program, you can specify through the program generation language only those facilities that your particular installation needs. The generation procedure automatically selects the appropriate modules to perform those functions.

The Controllers Offer High Availability

Many characteristics of the controller hardware and the network control program work together to ensure that availability of the controller to perform its normal teleprocessing functions is high.

For example, the network control program provides error recovery procedures (ERPs) that can recover from many intermittent hardware or transmission errors.

In most cases, the controller remains available to the rest of the network while the ERPs are being executed.

Some hardware options also increase the availability of the controllers. For example, two types of channel adapters have a two-channel switch feature that allows each of them to be attached to two CPU channels at once. If one channel fails, the channel adapter can be manually switched to the second channel. (This feature does not provide for simultaneous operation over both channels.)

An option that further increases availability in the larger models of the 3705 is their ability, when executing a network control program, to support two channel adapters of the high-performance type. This feature allows physical attachment to two different CPUs. If one CPU or channel adapter fails, the network control program can be switched to the second channel adapter either by command from the host access method or by reloading the NCP using the second channel adapter.

If both channel adapters have the two-channel switch, the 3705 can be attached to as many as four CPUs, making availability even higher. However, only one channel path at a time can be active.

The third type of channel adapter allows the 3705 to be attached to both processing units of a tightly-coupled multiprocessor through one channel adapter. The 3705 appears as the same I/O unit to each processing unit and can be accessed alternately by each processing unit in exactly the same manner. This facility allows the access methods for the 3705 (TCAM, VTAM, etc.) to run in either CPU with the path from the 3705 being transparent to the access method. This type of channel adapter can also provide an alternate path when attached to a uniprocessor.

For attachment of the communication lines, the 3705 can have up to four of the high-performance communication scanners. If one of the scanners fails, only those communication lines attached to it are affected; under most circumstances, the rest of the network can continue to operate as usual.

The Controllers Conserve CPU Resources

The controllers, when executing a network control program, can take over many functions that were previously performed by the teleprocessing access method. In doing so, they free resources in the host processor to handle more local processing jobs. The advantages to the host processor increase as the size of the teleprocessing network increases.

Most of the advantages to the host processor come from the removal of line-control and buffering functions from the access method to the controller. Much of the line-control information previously maintained by the access method in control blocks is now maintained by the network control program. In addition, the controller buffers data as it arrives from the stations and sends it to the host processor in blocks. Consequently, the access method can allocate buffers after an entire block has arrived from a station, and empty buffer space in host main storage is no longer tied up while data is being transmitted over the communication lines. Buffer requirements for the access method are therefore reduced, especially when input from the network is high.

The network control program can also take over some of the processing functions, such as date-and-time insertion, previously assigned to the access method.

Including these functions in the network control program saves the host processor both the time and the main storage required by the processing programs.

The Controllers Use a Single Subchannel Address

An advantage to the entire data processing installation is that a local controller, when executing a network control program, occupies a single control-unit position on the channel and requires only a single subchannel address to communicate with the host processor. (The IBM 2701, 2702, and 2703 require a separate subchannel address on a byte-multiplexer channel for each communication line in the network.) Therefore, if the controller is attached to a multiplexer channel, many subchannel addresses are still available for the attachment of other peripheral I/O equipment, and the channel facilities can be better utilized.

Also because of this characteristic, the 3705 with the network control program can be attached to a System/370 selector channel, regardless of the number of communication lines in the network. This capability is advantageous to a teleprocessing subsystem with high-speed communication lines and high throughput requirements.

The Design of the Controllers Increases Reliability and Reduces Overhead

The controllers are designed so that data is transferred between remote stations and the host processor with maximum reliability and efficiency. The controllers have four interrupt levels, performing those functions that are most critical at the highest priority level. Correspondingly, the network control program has five program levels, the first four paralleling the hardware interrupt levels, the fifth performing the functions that are not critically time-dependent.

As an example of the type of priorities established by the interrupt scheme, the first interrupt level (both hardware and program) handles those situations that require immediate attention—hardware and program checks and requests for IPL (initial program load), among others. If these conditions are not resolved immediately, normal operation of the controller is impossible. Therefore, they receive highest priority.

The most critical of the normal teleprocessing functions are handled at the second interrupt level. These are the servicing of the communication lines and the handling of data as it arrives and leaves. The controller hardware and the control program interact very closely at this level to prevent loss of data arriving on a line.

The controllers have four groups of eight general registers. One group is associated with each of the three lower program levels, and the fourth is shared by the first two program levels. This feature eliminates much of the overhead involved in saving and restoring register contents when passing control from one level to another. Therefore, the controllers can devote more time to the network-control functions.

Additional overhead can be eliminated in a local 3705 if one of the high-performance channel adapters is installed. These adapters use *cycle steal* to transfer data. Cycle steal allows the channel adapter to transfer data to or from storage without interfering with the logic of the control program. Program execution is simply suspended for the length of one machine cycle, during which the data is transferred. Thus the overhead involved in regular program interrupts is eliminated.

The Controllers Provide Many Error Recovery and Diagnostic Facilities

The network control program has a number of error recovery procedures and diagnostic facilities to enhance the reliability and serviceability of the controllers.

Some error recovery procedures (ERPs) are executed automatically by the network control program when a transmission error occurs. If these procedures fail to recover from the error, the program can perform other ERPs. In some cases, the program can notify the access method of the error and allow the access method to try to solve the problem.

The network control program also collects statistics on errors that occur for each line and sends these statistics to the host processor when a given count is reached. In addition, the checkpoint/restart option can be specified for the network control program, versions 1 and 2. If this is included, the program sends the host processor records containing the status of each communication line in the network whenever requested by the access method. These records can then be used when the controller is restarted to restore the network to its status at the last checkpoint before closedown.

Other diagnostic aids are also available for the controllers. Online terminal tests can be executed for the stations in the teleprocessing network. In addition, a diagnostic wrap facility enables the controller to test the communication line attachment hardware to determine whether problems are in the controller hardware or in the communication lines. The network control program, version 5 also provides online line tests for testing communications lines.

Chapter 2: Communications Controller Hardware Concepts

This chapter describes segments of hardware that make up the IBM 3704 and 3705 controllers. Figure 5 summarizes the differences between the two machines.

The 3705 Hardware

The 3705 is available in 20 models, based on the amount of storage and physical line-attachment capability. Each model is designated by a letter and a number, such as Model C3. The letter indicates the maximum line-attachment capability, and the number indicates the amount of storage. All C-models, for example can attach up to 256 communication lines for half-duplex operation, and all 3-models have 80K bytes of storage.

Figure 6 shows the storage capacity of each 3705 model and the maximum number of lines for half-duplex operation that can be attached to each. (A line that operates in duplex mode, such as a local/remote communication link, counts as two half-duplex lines.) The actual number of lines that the control program can support depends on many factors, such as the line speeds required and the throughput capacity of the control program.

All models of the 3705 contain a central control unit, a control panel, and at least 16K bytes of storage. In addition, they contain provisions for mounting a channel adapter (or a remote program loader), a two-channel switch, a communication scanner, and line interface bases and line sets to attach up to 64 communication lines for half-duplex operation. As the models increase in size, the available hardware options also increase, allowing the mounting of two channel adapters, two two-channel switches, and the storage and line-attachment capabilities as noted in Figure 6. (Channel adapters and two-channel switches can be installed only in a controller intended for attachment to a CPU channel; the two-channel switch is not available with a type 3 channel adapter.)

Models of the 3705 can be upgraded to larger models at the user's installation.

Figure 7 shows the maximum configuration of the 3705 hardware. A brief description of the functions of each segment of hardware follows.

	3704	3705
Maximum number of lines for half-duplex operation	32	352
Maximum line speed (bits per second)	50,000	50,000
Number of communication scanner types available	2	2
Maximum number of communication scanners installable	1	4
Number of channel adapter types available	1	3
Maximum number of channel adapters installable	1	2
Range of storage capacity (bytes)	16K-64K	16K-240K
Size of storage increments	16K	32K

Figure 5. Summary of Differences between 3704 and 3705 Controllers

Model	*Maximum Number of Half-Duplex Lines*	*Amount of Storage (Bytes)*
A1	64	16K
A2	64	48K
B1	160	16K
B2	160	48K
B3	160	80K
B4	160	112K
C1	256	16K
C2	256	48K
C3	256	80K
C4	256	112K
C5	256	144K
C6	256	176K
D1	352	16K
D2	352	48K
D3	352	80K
D4	352	112K
D5	352	144K
D6	352	176K
D7	352	208K
D8	352	240K

Figure 6. Communication Line and Storage Capacities of the 3705 (by Model)

The Central Control Unit

The central control unit contains the circuits and data-flow paths needed to execute the 3705 instructions and to control 3705 storage and the attached adapters. It also includes a storage-protection mechanism. The central control unit operates under the control of the 3705 control program.

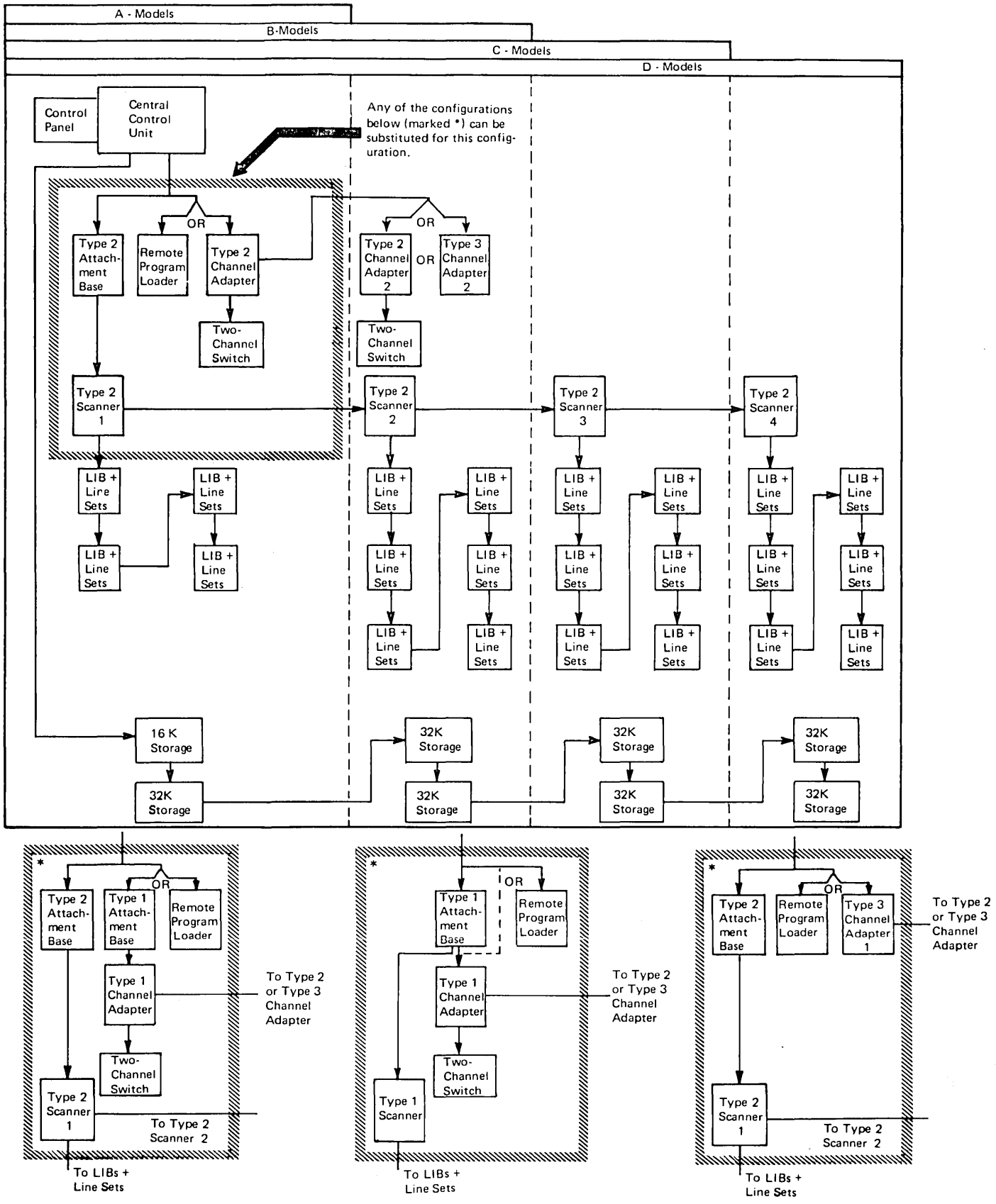
The Control Panel

The 3705 control panel contains the switches and indicators necessary to control certain 3705 functions manually. Some of the functions provided by the control panel are the ability to store and display information in 3705 storage and registers; the control and indication of power; indications of controller status; operator/controller communication controls; and diagnostic controls. The 3704 and 3705 *Control Panel Guides* explain how to use the control panel.

A remote 3705 will, in many installations, operate largely unattended. Two useful features are available for a remote 3705: unit protection and remote power off.

The unit protection feature is a lock switch that allows all control panel switches (except Power On/Off) to be disabled. This prevents unauthorized or inadvertent use of the panel to modify the control program being executed.

The remote power off feature allows power to be turned off by command from the host processor (via the local controller). This eliminates the need to have someone present to turn power off manually at the end of the day's teleprocessing operations. Power must be turned on manually, however, at the remote controller's panel.



Note: Only one each of the Type 1 Scanner and the Type 1 Channel Adapter may be installed.

Figure 7. Maximum Hardware Configuration of the 3705

3705 Storage

The amount of 3705 storage ranges from 16K bytes (16,384) to 240K bytes (245,760), in 32K increments. The 3705 model numbers indicate the amount of storage installed, as previously explained.

The 3705 Adapters

The communication scanners for the 3705 come in two versions. The channel adapters (CA) come in three versions. The type 1 scanner and type 1 CA have low functional capabilities and require more control by the 3705 control program than do the other adapters. The type 3 CA has the same performance and throughput characteristics as the type 2, but allows attachment to two channel interfaces, both of which may be enabled (though not active) at the same time.

Figure 8 shows all possible combinations of communication scanners and channel adapters, including the maximum number of each type that can be installed in a 3705 and in which of the models they can be installed. The remote program loader referred to in Figure 8 is described later in this chapter.

Combination	Maximum Number per 3705 Model			
	A	B	C	D
Type 1 CA* and	1	1	1	1
Type 1 Scanner	1	1	1	1
Type 1 CA* and	1	1	1	1
Type 2 Scanner	1	2	3	4
Type 2 or				
Type 3 CA* and	1	2	2	2
Type 2 Scanner	1	2	3	4
Type 1 CA and	--	1	1	1
Type 2 or				
Type 3 CA and	--	1	1	1
Type 1 Scanner	--	1	1	1
Type 1 CA and	--	1	1	1
Type 2 or				
Type 3 CA and	--	1	1	1
Type 2 Scanner	--	2	3	4
Type 2 CA and	--	1	1	1
Type 3 CA and	--	1	1	1
Type 2 Scanner	--	2	3	4

* or one remote program loader, if the 3705 is a remote controller. Regardless of model, a 3705 can contain only one remote program loader.

Figure 8. 3705 Channel Adapter/Communication Scanner Combinations

Attachment Bases

An attachment base is a required feature for support of the 3705 adapters. Two types of attachment bases are available: the type 1 attachment base and the type 2 attachment base.

The type 1 attachment base provides common controls to the central control unit for both the type 1 scanner and the type 1 CA. The type 2 attachment base provides common controls to the central control unit and line addressing controls for the type 2 scanners.

One or both of the attachment bases are required, depending on the type of scanner and CA installed in the 3705. The requirements are as follows:

Hardware Installed	*Attachment Base Required*
Type 1 Scanner with Type 1 CA	Type 1 Attachment Base
Type 2 Scanner with Type 1 CA	Type 1 and Type 2 Attachment Bases
Type 2 Scanner with Type 2 CA or Type 3 CA	Type 2 Attachment Base

Channel Adapters (Local 3705 Only)

Three types of channel adapters are available for the 3705. The type 1 CA provides attachment to an IBM System/360 or System/370 byte-multiplexer channel. The type 2 and type 3 CAs provide attachment to an IBM System/370 selector, byte-multiplexer, or block-multiplexer channel. The type 3 CA enables the 3705 to be attached to System/370 Model 158 and 168 tightly-coupled multiprocessor systems as a symmetrical shared I/O unit and to uniprocessors as an I/O unit with an alternate path capability.

With any type of channel adapter the 3705, when executing the network control program (NCP), appears as a single control unit on the channel and uses a single subchannel address. The emulation program requires multiple subchannel addresses, just as the IBM 2701, 2702, and 2703 do.

Type 1 Channel Adapter: The type 1 CA can handle only a relatively low volume of throughput and requires intervention from the 3705 control program for each data transfer burst. It is, however, adequate for many small networks and costs less than the type 2 and type 3 CAs.

Type 2 Channel Adapter: The type 2 CA transfers data by cycle steal, requires less intervention from the 3705 control program than the type 1 CA, and can handle a larger volume of throughput.

Type 3 Channel Adapter: The type 3 CA provides the same capabilities as the type 2 CA. In addition, the type 3 CA can be attached to two CPU channels. These two channel interfaces can be simultaneously enabled, and alternate (though not simultaneous) operation over the two interfaces is permitted. When a channel I/O operation over one channel interface is being executed, an I/O initiation attempt by the second channel (attached through the type 3 CA's second interface) causes a Busy status to be presented over that interface. Having given a Busy status, the adapter generates an asynchronous Device End when the I/O operation causing the Busy state has been completed on the opposite channel interface.

The type 3 CA can be enabled to either interface or to both at the same time. Enabling and disabling of the channel interfaces are controlled by manual switches located on the 3705 control panel. A pair of enable/disable switches exists for each type 3 CA (one for each channel interface).

Attachment of Multiple Channel Adapters: Up to two channel adapters can be installed in the B, C, and D models of the 3705. They may be either two type 2 CAs, two type 3 CAs, one type 1 and one type 2 CA, one type 1 and one type 3 CA, or one type 2 and one type 3 CA. If equipped with two high-performance channel adapters (type 2 and type 3), the 3705 can be attached to two independent CPU systems.

Network Control Program Support for the Channel Adapters: The network control program (NCP) can support either the type 1, the type 2, or the type 3 channel adapter. However, a network control program can contain the code for only one type of channel support at a time: type 1 support (for the type 1 CA) or type 2 support (for the type 2 or type 3 CA). Therefore, if the 3705 is equipped with a type 1 CA and either a type 2 or a type 3 CA, the nonsupported channel adapter should be disabled when the 3705 is operating in network control mode.

If the 3705 is attached to two independent CPU systems (whether uniprocessors or multiprocessors) through two type 2 or type 3 CAs, the first two versions of the network control program (NCP 1 and NCP 2) can contain the option of switching from one channel adapter to the other, thus providing a backup capability. In this case, one CPU is designated to the NCP as the primary CPU and the other as the secondary CPU. The network control program exchanges data only with the primary CPU. However, it accepts from either channel a command to reverse the roles of the CPUs. The secondary CPU then becomes the new primary CPU and the old primary CPU becomes the new secondary CPU. The NCP exchanges data only with the new primary CPU until it again receives a command to switch CPUs.

Emulation Program Support for the Channel Adapters: The emulation program can operate only with the type 1 channel adapter. Therefore, when the 3705 with both types of channel adapters is operating with the stand-alone version of the emulation program, the type 2 CA or type 3 CA should be disabled.

Partitioned Emulation Support for the Channel Adapters: A network control program with the PEP extension can contain the code to support both types of channel adapters. (Operation in emulation mode is possible only with the type 1 channel adapter.) If the 3705 is equipped with a type 1 CA and a type 2 or type 3 CA, the type 1 adapter handles data interchanges for communication lines in emulation mode, and the type 2 or type 3 adapter handles data interchanges for those in network control mode.

The Two-Channel Switch Feature: Both the type 1 and the type 2 channel adapters can have a two-channel switch. With this feature, the 3705 can be attached to two channels through one channel adapter. (The channels can be attached to the same CPU or to two different CPUs.) However, only one of the channels can be enabled for operation at a time. The channel to be enabled is selected by means of a manual switch on the 3705 control panel.

If two CAs are installed and both have a two-channel switch, the 3705 can be attached to four channels (and, consequently, to as many as four CPUs).

The two-channel switch feature for the type 1 and type 2 CA should not be confused with the enable/disable switches for the type 3 CA.

Remote Program Loader (Remote 3705 Only)

A 3705 used as a remote controller requires a remote program loader instead of a channel adapter. The remote program loader makes it possible to load a network control program, version 5, from the host processor via the local controller and the local/remote communication link. The remote program loader includes a small auxiliary storage device and a read-only storage unit. The auxiliary storage device contains loading, dumping, and diagnostic routines.

A 3705 equipped with a remote program loader cannot have a channel adapter.

Communication Scanners

The communication scanners provide the connection between the communication-line attachment hardware (line interface bases) and the central control unit. The primary function of the scanners is to monitor the communication lines for service requests.

The 3705 can have either the type 1 communication scanner or the type 2 communication scanner, but not both. Only one type 1 scanner can be installed in the

3705. Up to four type 2 scanners can be installed, depending on the 3705 model selected. The A-models can have only one type 2 scanner. B-models can have up to two; C-models, up to three; and D-models, up to four type 2 scanners.

The type 1 scanner interrupts the 3705 control program for each bit that arrives or leaves over a communication line. The program assembles and disassembles characters.

The type 2 scanner hardware assembles and disassembles characters. It interrupts the control program only when an entire character has arrived on or left from a line.

For either scanner, the actual number of communication lines that can be attached depends upon the speeds required; the higher the maximum speeds, the smaller the number of lines the scanner can handle.

Communication scanners service local/remote communication links as well as communication lines to remote stations. The scanner servicing a local/remote communication link may be either type 1 or type 2.

Line Interface Bases

Communication lines are attached to the 3705 through line interface bases (LIBs). Several LIB types are available to handle requirements for different types of line terminations. Depending upon the type of line termination, as many as 16 communication lines can be attached through one LIB. The A-models of the 3705 can have a maximum of four LIBs; the B-models, a maximum of 10; the C-models, up to 16, and the D-models, as many as 22 LIBs.

Communication lines are attached to LIBs through line sets. A single line set may provide the interface for one or two communication lines depending upon the type of interface. The types of LIBs and the line sets that can be installed in them are described in Appendix C, "3704 and 3705 Line Interface Bases and Line Sets". The characteristics of the interface between the line sets and common-carrier facilities are described in the *Original Equipment Manufacturers' Information* publication (GA27-3053).

Extended Environment Feature (Remote 3705 Only)

A 3705 equipped with the remote program loader may have the extended environment feature, which allows the controller to operate in a location without air conditioning. The minimum ambient temperature is 50° F (10° C); the maximum is 100° F (38° C). Without the extended environment feature, the allowable temperature range is 60° F (15.5° C) to 90° F (32.2° C).

Internal Air Circulation Features (Remote 3705 Only)

A remote 3705, if equipped with the extended environment feature, also requires the internal air circulation feature for each storage block in the controller. The internal air circulation features provide improved air cooling of the controller storage. A separate internal air circulation feature is required for each storage block in the controller. A 3705 having 80K bytes of storage, for example, requires three internal air circulation features: one for the first 16K storage block and one for each of the two 32K blocks.

The 3704 Hardware

The 3704 consists of a single module that contains the central control unit; the control panel; storage ranging from 16K (16,384) bytes to 64K (65,536) bytes in 16K increments; a communication scanner; the line-attachment hardware necessary to connect as many as 32 communication lines for half-duplex operation; and either (1) a channel adapter for attachment to an IBM System/360 or System/370 channel, or (2) a remote program loader. Figure 9 illustrates the maximum configuration of the 3704 when the control program is a network control program, version 5, or an emulation program that runs under OS/VS or DOS/VS. Previous versions of the NCP and the EP support only one line interface base (which must be type A1) with the type 2 scanner. A brief description of the function of each segment of hardware follows.

The Central Control Unit

The central control unit contains the circuits and data-flow paths needed to execute the 3704 instructions and to control 3704 storage and the attached adapters. It also includes a storage-protection mechanism. The central control unit operates under the control of the program resident in the 3704.

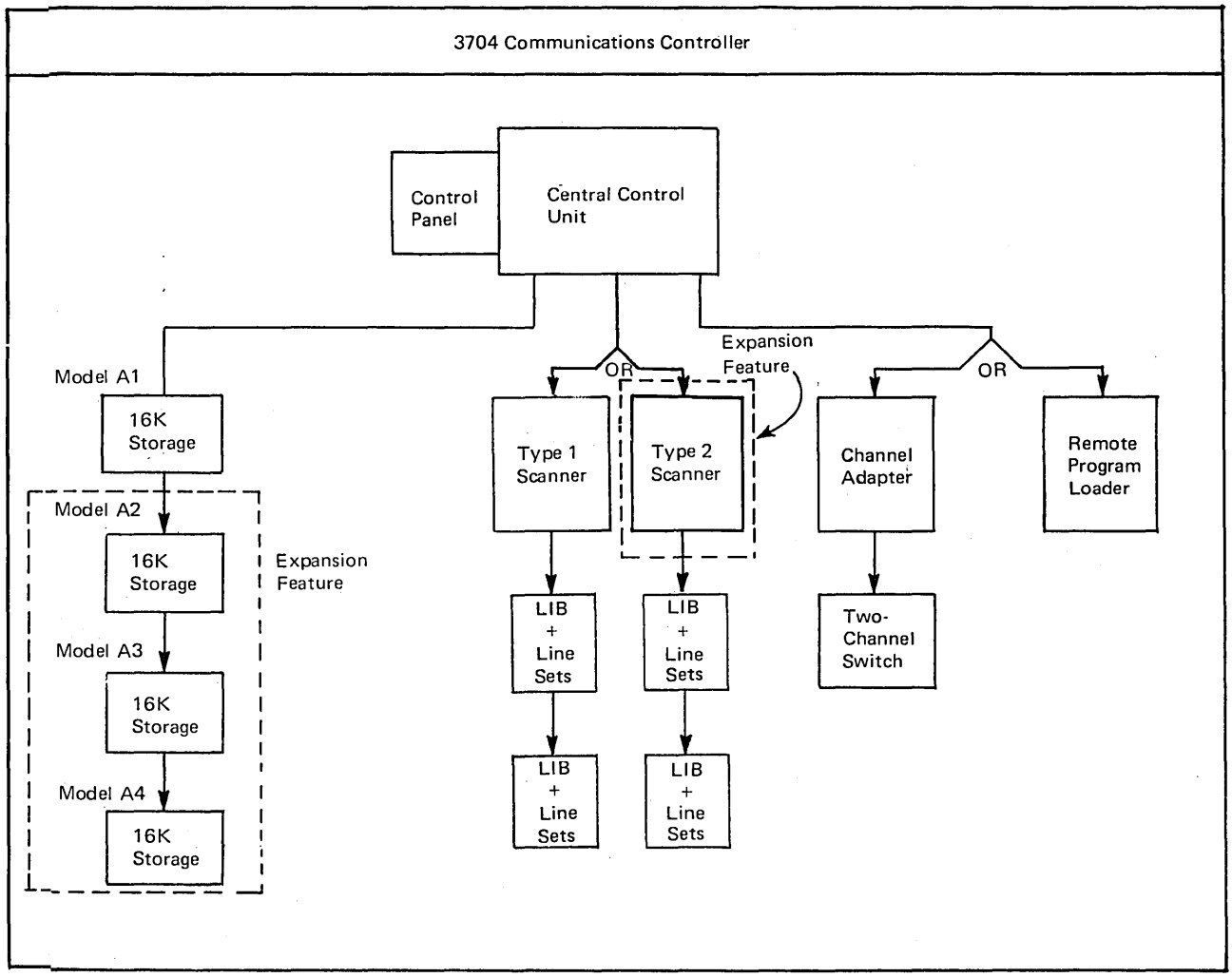


Figure 9. Maximum Hardware Configuration of the 3704

The Control Panel

The 3704 control panel contains the switches and indicators necessary to control certain 3704 functions manually. Some of the functions provided by the control panel are the ability to store and display information in 3704 storage and registers; the control and indication of power; indications of controller status; operator/controller communication controls; and diagnostic controls. Like the 3705, the unit protection lock switch and remote power off features are available for remote 3704 controllers.

3704 Storage

Storage in the 3704 is available in 16K increments up to 64K bytes. The base machine includes 16K bytes of storage. To install storage above 16K, an expansion feature is required.

The amount of storage in the 3704 is designated by 3704 models. Figure 10 shows the model names and amount of storage in each.

The 3704 Channel Adapter (Local 3704 Only)

The 3704 provides a single channel adapter, the type 1 channel adapter, for attachment to an IBM System/360 or System/370 byte-multiplexer channel. This channel adapter is identical to the type 1 channel adapter for the 3705.

The channel adapter can have the two-channel switch feature, which allows the 3704 to be attached to two channels. (The channels can be attached to the same CPU or to two different CPUs.) However, only one of the channels can be enabled for operation at a time. The channel to be enabled is selected by means of a manual switch on the 3704 control panel.

Remote Program Loader (Remote 3704 Only)

A 3704 used as a remote controller requires a remote program loader instead of a channel adapter. The remote program loader makes it possible to load a network control program (NCP 5) from the host processor, via the local controller and the local/remote communication link. The remote program loader includes a small auxiliary storage device and a read-only storage unit. The auxiliary storage device contains loading, dumping, and diagnostic routines.

A 3704 equipped with a remote program loader cannot have a channel adapter.

Communication Scanners

The 3704 can be equipped with either a type 1 or a type 2 communication scanner.

The type 1 scanner interrupts the control program for each bit that arrives or leaves over a communication line. The program assembles and disassembles characters.

Model	Maximum Number of Half-Duplex Lines	Amount of Storage (Bytes)
A1	32	16K
A2	32	32K
A3	32	48K
A4	32	64K

Figure 10. Communication Line and Storage Capacities of the 3704 (by Model)

The type 2 scanner interrupts the program only when an entire character has been received from or transmitted onto the communication line. The scanner hardware assembles and disassembles characters.

For either scanner, the actual limit on the number of communication lines that can be attached depends upon the speeds required; the higher the maximum speeds, the smaller the number of lines the scanner can handle. For specific line speeds and line configurations that each scanner can support, see the appropriate *Storage and Performance* manual.

Communication scanners service local/remote communication links as well as communication lines to remote stations. The scanner servicing a local/remote communication link may be either type 1 or type 2.

Line Interface Bases

Communication lines are attached to the 3704 through line interface bases (LIBs). One or two LIBs can be installed in the 3704. Depending upon the type of line termination, as many as 16 communication lines can be attached through one LIB.

Communication lines are attached to LIBs through line sets. A single line set may provide the interface for one or two communication lines depending upon the type of interface. The types of LIBs and line sets available for the 3704 are described in Appendix C, "3704 and 3705 Line Interface Bases and Line Sets". The characteristics of the interface between the line sets and common-carrier facilities are described in the *Original Equipment Manufacturers' Information* publication (GA27-3053).

Extended Environment Feature (Remote 3704 Only)

A 3704 equipped with the remote program loader may have the extended environment feature, which allows the controller to operate in a location without air conditioning. The minimum ambient temperature is 50° F (10° C); the maximum is 100° F (38° C). Without the extended environment feature, the allowable temperature range is 60° F (15.5° C) to 90° F (32.2° C).

Chapter 3: The System Support Programs

The IBM-supplied system support programs for the network control program (NCP) and the emulation program (EP) are available to help you install and use your communications controller. There are four system support programs: (1) a procedure for generating the control program, (2) an assembler, (3) a loader, and (4) a dump program. The loader and the dump program are utility programs. Each remote controller has a small auxiliary storage device containing load and dump routines. These routines are not part of the system support programs described below, which apply only to local controllers. Loading and dumping of a remote controller are described at the end of the chapter.

The system support programs for the network control program will run under (1) OS (Operating System) in an IBM System/360 or System/370, (2) OS/VS (Operating System/Virtual Storage) in a System/370, and (3) DOS/VS (Disk Operating System/Virtual Storage) in a System/370.

Support programs for the emulation program will run under (1) OS in a System/360 or System/370, (2) OS/VS in a System/370, (3) DOS in a System/360 or System/370, and (4) DOS/VS in a System/370.

Consult your IBM representative to determine the availability of the system support programs under each of the operating systems referred to above.

The generation procedure and the assembler are executed entirely in the CPU. (This need not be the host processor for the controller.) Each of the utilities is divided into two portions, one of which runs in the host processor and the other in the controller. Use of the system support programs is described in the *Control Program Generation and Utilities* and *EP Generation and Utilities* manuals. See Appendix D for a description of these publications.

Control Program Generation

You create the control program that meets the requirements of your teleprocessing subsystem by means of a control-program generation procedure. To help you generate the control program, IBM supplies (1) a generation language by which you specify network configuration and program options, and (2) a library of macro definitions from which the source statements are expanded.

The generation procedure is similar for both network control programs and emulation programs, although there are minor differences in the OS, DOS, OS/VS, and DOS/VS procedures. The generation languages for both control programs are also similar. However, more macros and operands are provided for defining a network control program than for an emulation program because of the greater number of network control options available. The following sections describe the generation language, some coding conventions, and how the generation procedure works. Some topics are addressed only for the network control program because they are not applicable to the emulation program. Generation procedures for the network control program and emulation program are covered in detail in separate publications, which are described in Appendix D.

The Control Program Generation Language

The control program generation language provides a high-level means for generating the control program for the 3704 or the 3705. The language is designed to

minimize the programming effort for even the most complex configuration of lines and stations.

The generation language is made up of macro instructions that fall into four categories according to the type of parameters they define. The types of macros are (1) system macros, (2) configuration macros, (3) block handling (BH) macros, and (4) a generation delimiter macro.

System Macros

The system macros provide information pertaining to controller hardware features, certain control program options, and program generation information such as data set names. The system macros specify, for example:

- The amount of storage installed in the controller.
- The size of buffers used for communications in network control mode.
- The type of channel adapter installed (for the 3705 and the network control program only).
- Optional facilities such as online terminal test and checkpoint/restart (available only for communication lines in network control mode).
- Optional dynamic control functions to be included in the network control program.
- The identifier of the controller (NCP 5 only).
- Whether the network control program is to operate in a local or a remote controller (NCP 5 only).

Configuration Macros

The configuration macros provide the information necessary to construct the tables needed by the control program to control the flow of data between the controller and remote stations or other controllers, and between a local controller and the host processor.

One group of these macros defines the characteristics of the elements in the teleprocessing network—line groups, communication lines (including local/remote communication links), clusters, terminals (or controllers), and components. You code a macro for each element in the network. The macros must be arranged in a specific order to associate a particular communication line with a particular line group, a particular terminal with a particular communication line, etc. The hierarchy from the highest level to the lowest level is: line group, line, cluster, terminal, component. For example, you would arrange the macros defining a line group with two lines, two terminals on each line, and two components on each terminal as follows:

```
Group definition
  Line definition
    Terminal definition
      Component definition
      Component definition
    Terminal definition
      Component definition
      Component definition
  Line definition
    Terminal definition
      Component definition
      Component definition
    Terminal definition
```

Component definition
Component definition

To define a local/remote communication link to which three controllers are attached, you would code:

Group definition
Line definition
Controller definition
Controller definition
Controller definition

Each macro is associated with the last higher-level macro that precedes it. This type of structure simplifies coding by allowing you to specify characteristics that are the same for all levels of a hierarchy only on the highest level. For example, if a characteristic pertains to all terminals on a multipoint communication line, you code that characteristic only on the macro that defines the line.

The rest of the configuration macros provide the following types of information:

- Information needed for data transfer between the host access method and the network control program; for example, average block size and buffer-unit size in the host processor (not applicable for emulation mode data transfer).
- Information describing the communication scanner(s) attached to the controller.
- Definition of the remaining control tables necessary to control the network; for example, lists of valid identification sequences for binary synchronous stations that call in over the switched communication network (not applicable for lines in emulation mode).

These configuration macros, unlike those that define the elements in the teleprocessing network, can appear in any order in relationship to each other in the control program generation input stream.

Block Handling Macros

The block handling (BH) macros apply only to messages transmitted over binary synchronous and start-stop communication lines in network control mode. They describe optional processing that the network control program can perform on a block of data before transferring the block to a station or to the host processor.

Some BH macros define *block handling routines* (BHRs) that perform specific processing functions. The BHRs specified by these macros perform the following types of processing:

- Inserting the date and/or time of day into blocks of data.
- Correction of text incorrectly entered from a station. The macro defines the character to be recognized by the BHR as a backspace character. The BHR deletes these characters from the text and overlays the characters preceding the backspace characters with the text that follows.

  Example:
  Input from terminal: CHARACTRE bksp bksp ER
  After processing by BHR: CHARACTER

Using the controller assembler, you can write additional block handling routines to process blocks in other ways. A BH macro allows you to include these routines in the network control program at the time the program is generated.

In a network control program with the PEP extension, block-handling routines may be associated only with communication lines in network control mode. No block processing is performed for lines in emulation mode. In addition, block

handling routines are not available for synchronous data link control (SDLC) lines in NCP 5.

The remaining BH macros provide for the grouping of block handling routines into block handlers and sets of block handlers. A *block handler* consists of one or more block handling routines defined by the individual BH macros. Many block handlers can be defined for a single network control program configuration. Special BH macros delimit the beginning and end of each block handler and provide a symbolic name for it. When multiple block handlers are defined, one must be completed before the next is defined.

Up to three block handlers are grouped into a *block handler* (BH) *set*, defined by another BH macro. Each block handler in a BH set can be executed at one of three points in time, as follows:

1. After a command has been received from the host access method for a teleprocessing unit but before it has been determined that the communication line is available.
2. After a command has been received from the host access method for a teleprocessing unit but only after the communication line is available.
3. When an input operation on a communication line ends.

Each BH set may be associated with one or more teleprocessing units. You can associate a BH set with a TP unit when generating a network control program by coding the name of the BH set as an operand of the configuration macro that defines the unit. With NCP 1 and NCP 2, you can also associate a BH set with a TP unit dynamically, or change the association of BH set and TP unit, through a Control command from the host access method that is communicating with the TP unit in network control mode.

Generation Delimiter Macro

The generation delimiter macro ends the control program generation input stream.

Coding the Generation Language

The generation language is designed to make coding as easy as possible. All the operands of the individual macros are keywords, so the programmer does not have to be concerned with the sequence in which he codes the operands. However, the relative order of the macros in the input stream is to some extent fixed.

Figure 11 illustrates the format of the input stream for a typical network control program generation. For communication lines in emulation mode, there are no non-positional configuration macros or block-handling macros.

General Logic Flow of the Control Program Generation Procedure

When you have coded the generation macros that describe the network connected to the controller, you generate the control program using the control program generation procedure. The generation procedure is a two-stage process (for OS, OS/VS, and DOS) or a three-stage process (for DOS/VS) that runs as a series of jobs in the host processor (or other CPU). Figure 12 illustrates the procedure for program generation under OS. Figure 13 illustrates the procedure for emulation program generation under DOS. (Similar procedures are followed for program generation under OS/VS and DOS/VS.)

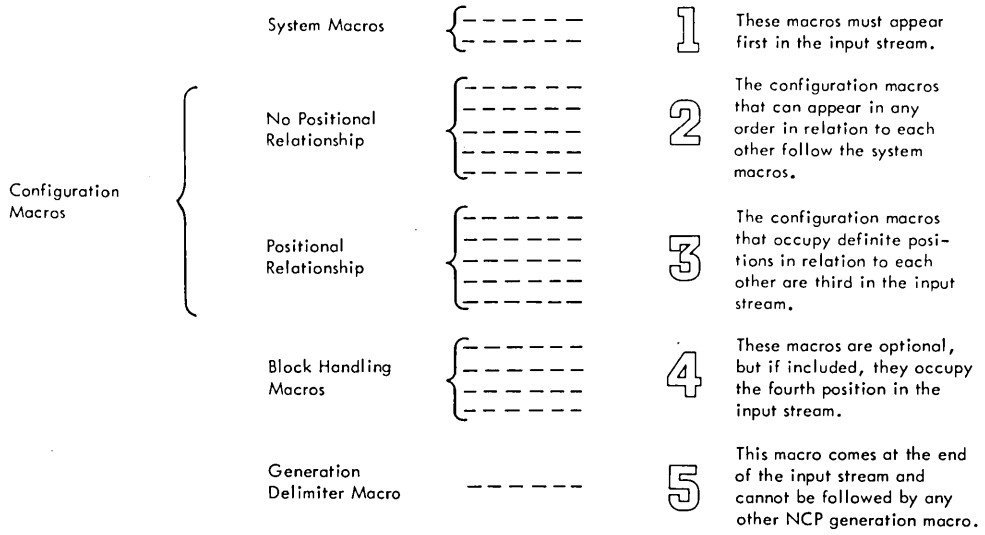


Figure 11. Format of the Input Stream for NCP Generation

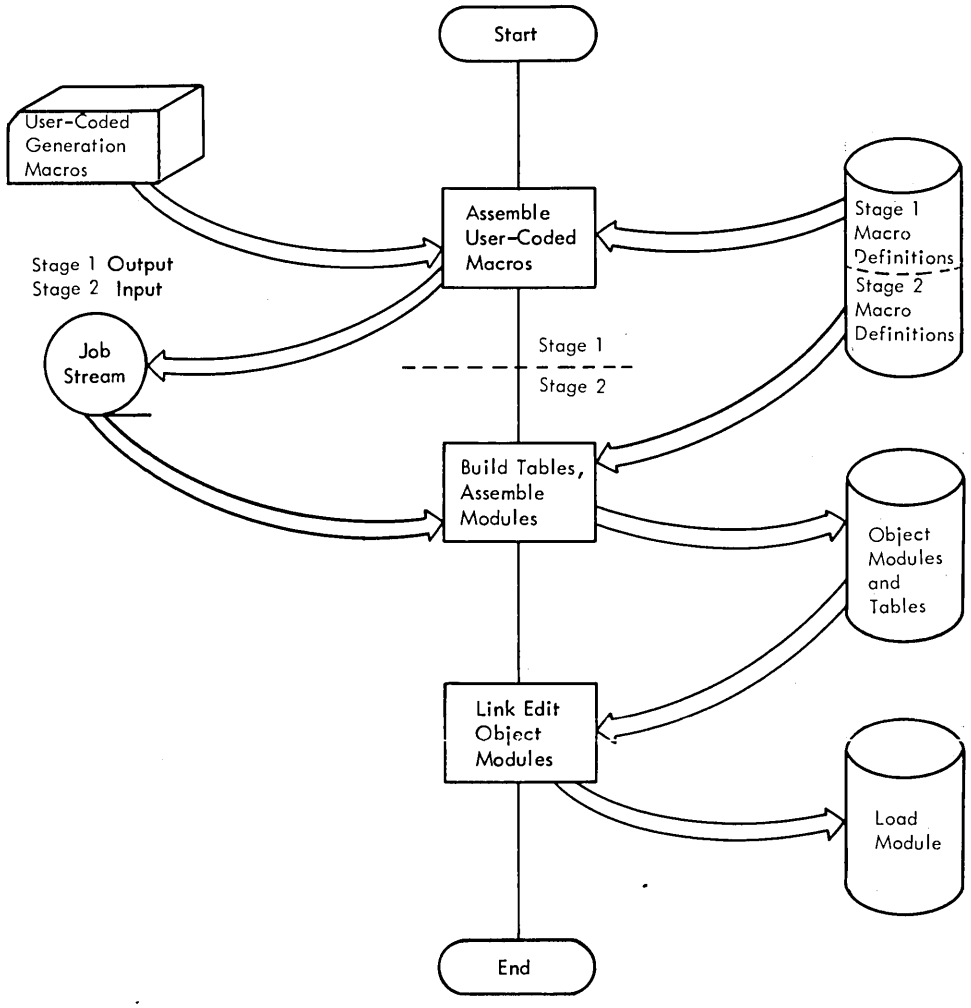


Figure 12. Example of the Control Program Generation Procedure under OS

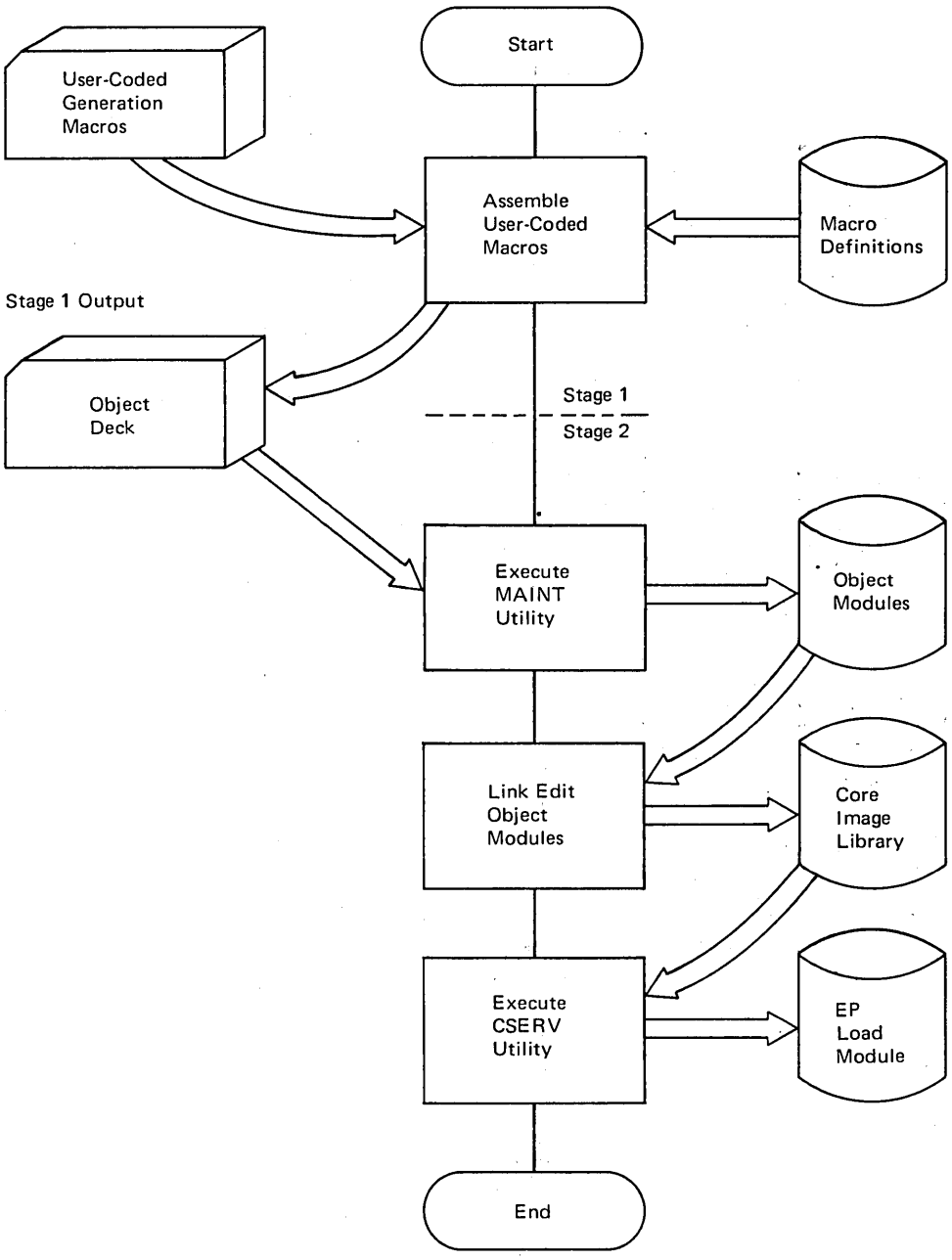


Figure 13. Example of the Emulation Program Generation Procedure under DOS

Stage One

In the first stage of the generation procedure, the macros you have coded are assembled by the controller assembler. If generating under OS or OS/VS, you may use an OS or OS/VS assembler, instead of the controller assembler, for stage one assembly. Generation under DOS (emulation program only) or DOS/VS requires the controller assembler. For OS, OS/VS, and DOS/VS output from the assembly is a job stream containing the data and control statements necessary to create the desired control program. The job stream is a sequential data set that can be directed to cards, tape, or a direct access storage unit. For DOS, assembly output is an object deck that is link edited with other emulation program modules in the stage two link edit step.

Intervention Between Stages of Control Program Generation

Intervention is required between stages of the generation procedure. If there are errors in the source statements entered as input to stage one, you receive a diagnostic message for each statement that contains an error. For severe errors, the source statements must be resubmitted until these errors are corrected.

Stage Two

If there are no severe assembly errors, you initiate the second stage of the generation procedure. The second stage creates the control program that will support the teleprocessing subsystem and perform the processing functions that you have specified.

For OS and OS/VS, the job stream from stage one contains the data necessary to select the appropriate program modules and build the proper tables. Using the information you coded in the generation macros, stage two first builds the tables, then assembles (using the controller assembler) the modules that are dependent on the network you define. Then the OS or OS/VS linkage editor is executed to combine the appropriate modules into the control program load module. Finally, the load module is stored on a direct access storage unit.

For DOS/VS, stage two of the generation procedure assembles the control tables and the program modules that are dependent on the network you define and creates job control statements and linkage editor statements for stage three. Stage three catalogs the tables and modules assembled in stage two and link edits them into a control program load module. The CSERV utility must then be executed to move the load module to a direct-access data set from which the loader utility may obtain it.

For DOS, the object deck produced by stage one is cataloged using the MAINT utility, then link edited with preassembled emulation program object modules. This results in an emulation program load module located in the core image library. The CSERV utility must then be executed to move the load module to a direct-access data set from which the loader utility may obtain it.

Generating Multiple Control Programs

You can generate as many network control program or emulation program load modules for a controller as you wish. Each program requires a separate generation, and each must have a different symbolic name in order that the loader can identify the load module to be transferred into the controller.

Multiple load modules are useful for installations that have several distinct applications for the teleprocessing subsystem. For example, if your installation uses only start-stop communication lines during the day and only binary synchronous lines at night, separate control programs for the separate configurations could reduce the amount of storage required for the controller and make the program operation more efficient.

The Controller Assembler

The controller assembler is available to assemble programs written in controller assembler language. In its external structure, it is very similar to the OS and DOS assemblers. The *Assembler Language* manual explains how to use the controller assembler. See Appendix D for a description of this manual.

The assembler operates on three kinds of instructions; (1) machine instructions (written in controller assembler language notation); (2) macro instructions; and

(3) assembler instructions. The assembler translates the machine instructions and the macro instructions into executable object code. The assembler instructions direct the assembler to perform certain operations during the assembly process, but they are not converted into executable code. These three types of instructions are similar to the types of instructions processed by the OS and DOS assemblers.

The Instruction Set

The instruction set for the controllers consists of 51 machine instructions. The instructions are represented to the assembler by mnemonic operation codes, usually followed by one or more operands. Most of the machine instructions are register-oriented. That is, they represent operations involving two registers, a register and immediate data, or a register and a storage area.

The assembler converts the machine instructions into two or four bytes of object code, depending on the length assigned to the particular instruction.

The *3704 and 3705 Principles of Operation* manual explains each of the machine instructions and gives the assembler language statement that corresponds to each.

Macro Capability of the Assembler

The macro language for the controllers is an extension of the controller assembler language. It provides a convenient method of generating a desired sequence of assembler language statements many times in one or more programs. Macro definitions can be coded in line in assembler-language programs or stored in a host library and called in when needed by means of a macro instruction coded in the program.

The Assembler Instructions

Instructions to the controller assembler are written as assembler pseudo operation codes, with or without operands. These instructions perform such functions as delimiting the beginning and end of sections of code, defining data areas, controlling the format of listings, and specifying base registers.

Uses of the Assembler

The uses of the controller assembler include: (1) preassembling user-written block handling routines, and (2) assembling the control program generation macros and application-dependent modules during the control program generation procedure.

The assembler enables you to add to the IBM-supplied network control program modules block handling routines (BHRs) that are unique to your applications (for start-stop and binary synchronous communication lines). Using the controller assembler language, you code BHRs to process the data in message blocks going to or coming from a station. Then you use the assembler to create object modules that are stored in the same library with the IBM-supplied network control program object modules. At program generation time, if you have coded the appropriate macros, the BHRs you have written are link-edited together with the IBM modules to form the network control program load module.

The Utilities

The loader and the dump programs help you start operation of the control program and locate errors. Both are utility programs, controlled by the appropriate job control statements and control cards.

These programs are used only for loading and dumping a local communications controller. A remote controller is loaded and dumped by interaction between the teleprocessing access method and utility routines in the remote controller, as described later in this chapter.

The Loader

The loader has two loading functions: (1) it transfers a diagnostic routine, the *initial test* routine, into the controller, and (2) it transfers the control program from host secondary storage into the controller.

The loading of the initial test routine occurs before the control program is loaded into the controller. This routine tests the hardware for conditions that could possibly result in failure of the controller after operation begins. If the initial test routine discovers any exceptional conditions, it causes a hard stop of the controller and cancels transfer of the control program across the channel. Indicators on the control panel are set to aid in isolating the problem.

Whenever the loader is invoked, the initial test routine is executed automatically. However, you can suppress execution of initial test by means of a utility control card entered as input to the loader.

The loader is invoked to load the control program in the following two instances:

- At start-up time. The loader is started by job control statements entered into the job stream by the operator.
- When the controller fails because of some error condition. The operator starts the loader in this case, too.

This does not mean, however, that IPL (initial program load) of the controller is always performed by the loader. TCAM, for example, has an optional loading facility that can automatically load the network control program at start-up time or reload it if the controller fails. Thus, operator intervention is not required if this option is selected for TCAM.

How the Loader Operates

The part of the loader that resides in the host processor handles all external input and output requirements of the loading process. This portion reads the control program load module from secondary storage and issues a Write command for each block of code to be transferred across the channel into the controller.

The portion of the loader that resides in the controller initializes the controller to prepare it for the data written from the host processor. It then communicates with the host portion, accepting blocks of code from the channel and positioning them appropriately in controller storage.

The Dump Program

The dump program dumps the contents of controller storage to help you isolate and correct problems when error conditions arise. You have three options when requesting a dump:

- You can specify the limits of the storage area to be printed out from the dump. Otherwise, you receive a printout of the complete dump (except for a small area at the beginning of storage).
- You can request a formatted dump of the network control program. In this case, the dump program isolates and labels certain control blocks, printing them at the beginning of the dump. (Formatting applies only to control blocks associated with communication lines in network control mode.)

- You can request that the mnemonic operation codes for all machine instructions be interleaved with the instructions in the dump.

Both formatted and unformatted dumps contain a hexadecimal representation of controller storage. In addition, all dumps include the contents of the general registers and the EBCDIC representation of all letters and numbers in the dump.

Note that after any dump (whether it be a complete storage dump or a dump of only a portion of storage), the control program must be reloaded before operation can be resumed.

How the Dump Program Operates

The dump program for OS has two job steps. The first step, which requires code in both the host processor and the controller, dumps the entire contents of controller storage and the contents of the general registers to a data set on host disk storage.

The first step then automatically invokes the second step, which runs entirely in the host processor. Step two first analyzes the utility control cards, on which you have specified the options desired for this dump (storage limits, formatting, etc.). You may request a printout of as many different areas of the dump as you wish by including a control card for each area. Then step two formats the dump when appropriate, reads the requested contents from the disk data set, translates them into printable hexadecimal characters, and when requested, interleaves the mnemonics with the instructions. Finally, it writes the requested portion(s) of the dump to an output data set to be printed out.

The host access method can also perform the functions of step one of the dump program. In this case, step two is not invoked automatically; you must initiate it as an independent job in order to print out the dump.

Unlike the OS dump program, the DOS dump program consists of only one job step and uses no intermediate disk data set. It is, however, functionally the same as the OS dump, except that no formatting is provided since the DOS dump is for the emulation program only. The OS/VS and DOS/VS dump programs provide the equivalent functions. Both programs provide optional formatting of control blocks associated with communication lines in network control mode.

After a dump, the controller is idle and must be reloaded before it can operate again.

Loading and Dumping a Remote Controller

A remote controller can be loaded or dumped only when the local controller to which it is connected is executing a network control program, version 5.

Loading

The access method can be notified in two ways that loading of a remote controller is required: (1) The operator at the host console can enter a command requesting loading, or (2) the remote controller can send a request for IPL in response to an attempt by the access method to initiate communication with it. The remote controller requests IPL after (1) its power is turned on, (2) the remote network control program abends, (3) the operator at the remote controller presses the Load switch, or (4) the utility program in the remote controller encounters an error during loading or dumping.

The access method initiates loading by sending a Load command to the remote controller. Utility routines in the remote controller (loaded from the auxiliary storage device under one of the four conditions described above) accept load module data blocks from the access method. After all load module blocks have been transferred to the remote controller, the utility routines wait until the access method next attempts to initiate communication with the remote controller before transferring control to the newly loaded network control program.

After a power-on sequence and usually after the Load switch is pressed, the remote controller executes diagnostic routines that test the controller hardware. When these routines are not run, it may be appropriate for the access method to obtain a storage dump before the loading process begins. To do so, the access method sends a Dump command instead of a Load command. After the dumping action is completed, the access method can send a Load command.

Dumping

A command entered at an operator console informs the access method that dumping is required. Alternatively, a dump may be initiated by a request for IPL from the remote controller; under certain circumstances the access method may determine that the controller should be dumped before it is loaded. (For example, if the remote network control program abends, the access method may request a dump before reloading.) In either case, the access method sends a Dump command to the remote controller to initiate the dumping action.

It is the responsibility of the access method to format the storage dump as needed and cause it to be printed at the host processor.

Chapter 4: Network Control Program Concepts

The network control program (NCP) resides in the communications controller to control the transfer of data between the stations in a teleprocessing network and the host processor. At least 48K bytes of storage are required to run the network control program; therefore, 3705 model A2, B2, C2, D2, or higher, or 3704 model A3 or A4 must be installed.

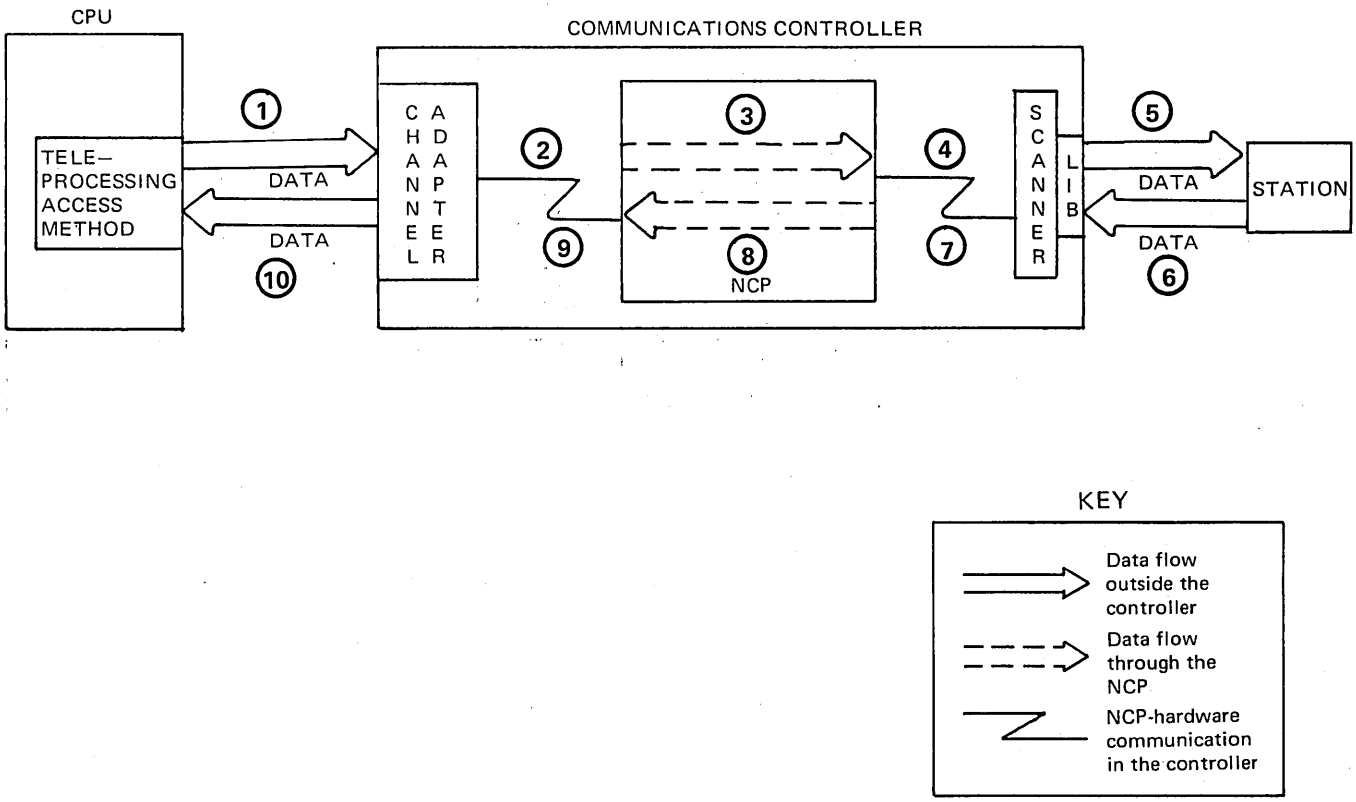
The primary functions of the network control program are related to the transmitting and receiving of data. In addition, for start-stop and binary synchronous (BSC) stations, the program can optionally process the data passing through the controller, either by means of IBM-supplied processing programs or by user-coded programs.

The network control program includes routines to attempt error recovery, to record error statistics, and to perform diagnostic tests. These routines enable the program to recover from many transmission errors without user intervention. When irrecoverable errors occur, these routines aid in finding the source and correcting the error.

The network control program performs the foregoing functions whether it is executed by a local controller or by a remote controller. In a configuration that includes both local and remote controllers, the network control programs in the two controllers must be at the version 5 level. The NCPs in the local and remote controllers are called respectively the *local NCP* and the *remote NCP.* Each program performs the message control function for its respective controller.

The network control program interacts with the communication scanners and the channel adapters to control the flow of data through the teleprocessing subsystem. Interaction with the adapters occurs through interrupt mechanisms. Figure 14 illustrates data flow between station and CPU through a single controller attached to a host processor channel. Figure 15 shows the data flow through a local and a remote controller.

The network control program communicates with the access method in the host processor to control the logical flow of data. The interface between the two programs is a field of control information. Each block of data passing between the controller and the host processor is preceded by control information that identifies the data. Control information can also be sent alone by the access method to request operations from the network control program. Conversely, the program can send control information to the access method to signal completion of an operation or to report the status of an element of the teleprocessing network. Message data may or may not follow the control information. Figure 16 shows how the network control program and the access method communicate with each other. The attached data is optional, depending on the operation. The local program inspects the control information field of each block received from the access method. By doing so, it determines which controller is to transmit the block to the receiving station. (In the control information field the access method must specify both the receiving station and the controller to which that station is connected.)



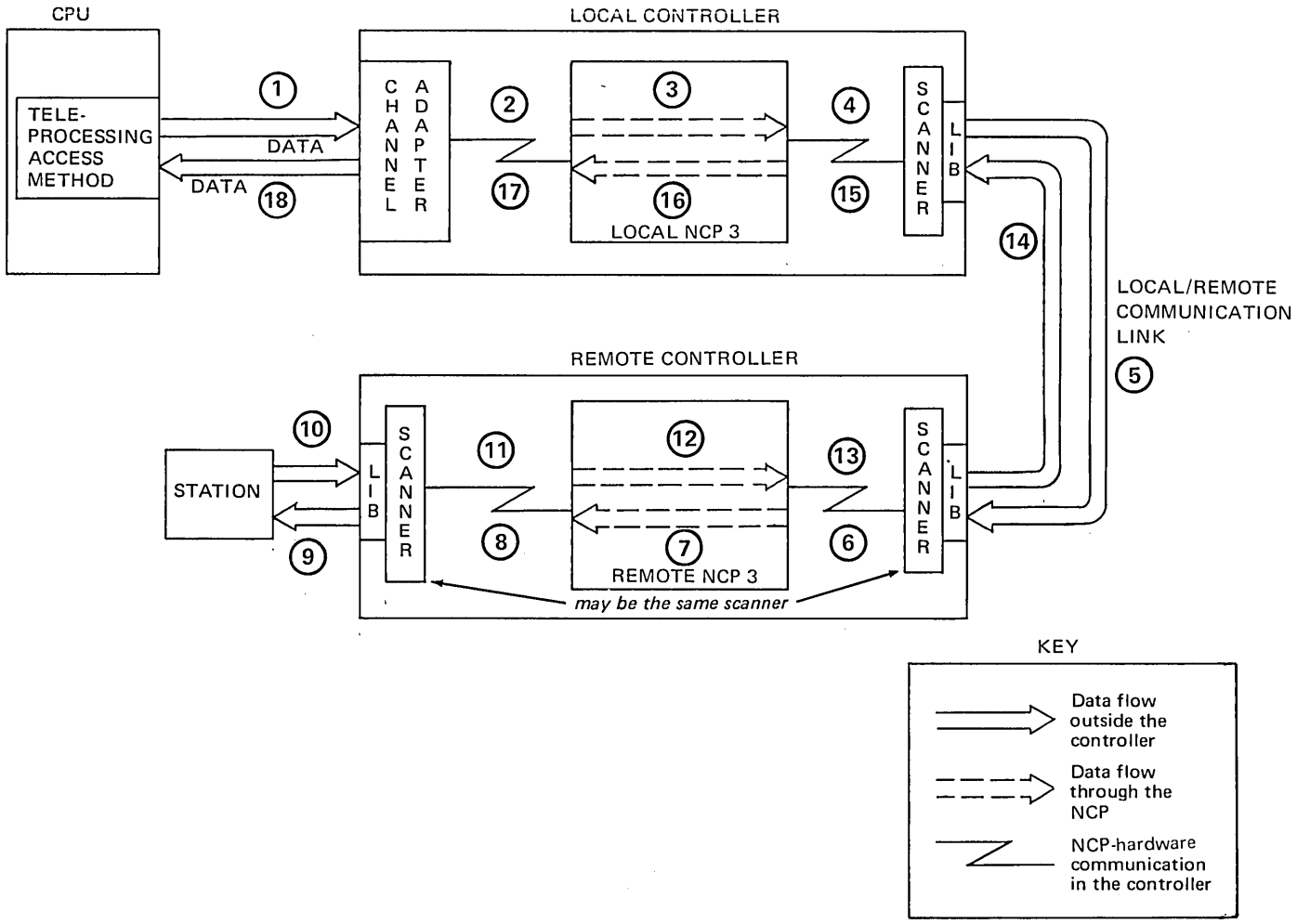
CPU to Station

1. CPU sends data to the controller.
2. Channel adapter notifies NCP as data arrives.
3. NCP processes data, prepares it for station.
4. NCP activates communication scanner when data is ready to be sent to station.
5. Data is transmitted across communication line to station.

Station to CPU

6. Station sends data to the controller.
7. Communication scanner notifies NCP as data arrives.
8. NCP processes data, prepares it for CPU.
9. NCP activates channel adapter when data is ready to be sent to CPU.
10. Channel transfers data to CPU.

Figure 14. Data Flow between CPU and Station through a Local Controller



CPU to Station

1. CPU sends data to local controller.
2. Channel adapter notifies NCP as data arrives.
3. Local NCP determines that destination of data is a station connected to the remote controller.
4. Local NCP activates communication scanner when data is ready to be sent to remote controller.
5. Data is transmitted over local/remote communication link to remote controller.
6. Communication scanner notifies remote NCP as data arrives.
7. Remote NCP processes data, prepares it for station.
8. Remote NCP activates communication scanner when data is ready to be sent to station.
9. Data is transmitted over communication line to station.

Station to CPU

10. Station sends data to remote controller.
11. Communication scanner notifies remote NCP as data arrives.
12. Remote NCP processes data, prepares it for CPU.
13. Remote NCP activates communication scanner when data is ready to be sent to local controller.
14. Data is transmitted over local/remote communication link to local controller.
15. Communication scanner notifies local NCP as data arrives.
16. Local NCP prepares data for CPU.
17. Local NCP activates channel adapter when data is ready to be sent to CPU.
18. Channel transfers data to CPU.

Figure 15. Data Flow between CPU and Station through a Local and Remote Controller

The format of the control information field varies according to the type of station to which the message is directed. If the station uses binary synchronous or start-stop communications, the network control program (NCP) retains the entire control information field and transmits only the message data to the station. If the station communicates via synchronous data link control (SDLC), the NCP retains a portion of the control information and transmits the remainder with the message data to the station. Likewise, SDLC stations, when transmitting to the communications controller, prefix the message data with a field of control information; the NCP adds to the control information before returning the block to the host processor.

If the receiving station is connected to a remote controller, the local network control program simply forwards the entire block—control information and data—to the remote controller. The remote NCP then forwards the message data (or message data and abbreviated control information) to the station as described above. (In order for a remote controller to communicate with SDLC stations, NCP 5 must be running.)

To show both uses of the control information field and to illustrate how messages are routed through a remote controller, NCP 5 is used as the control program in Figure 16. NCP 1 and NCP 2 communicate in a similar manner with binary synchronous and start-stop stations, though only through a local controller.

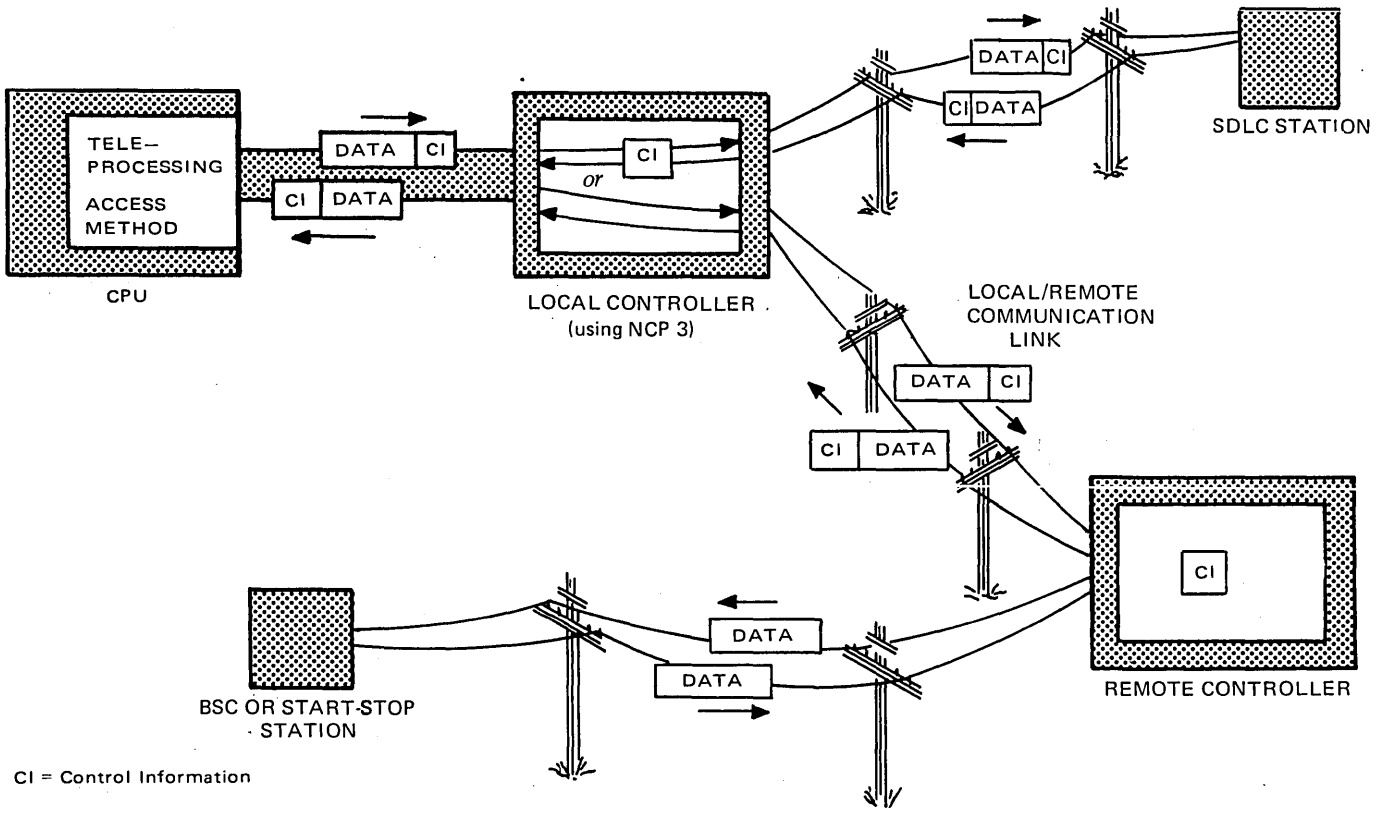


Figure 16. Logical Data Flow between the Access Method and Stations via Local and Remote Controllers

Functions of the Network Control Program

The network control program performs a wide range of functions for the teleprocessing subsystem. Certain functions are standard for any network control program; others are optional, selected as part of the program generation procedure. The *NCP Generation and Utilities* manuals describe the purpose of each function and explain how to code program generation statements to include the function. (See Appendix D for a description of these publication.)

Standard Functions

Standard functions of the 3704 and 3705 with the network control program include those that any transmission control unit performs, such as control character recognition, communication-line time-out control, error checking, and character assembly and disassembly. In the controllers, these functions are performed for the most part by the network control program rather than by hardware. In addition to these functions, the following are standard features of the network control program.

Communication Control

The network control program takes over most of the control of the communication lines from the teleprocessing access method. The standard communication control functions are:

- Polling and addressing of teleprocessing units on multipoint communication lines.
- Dialing and answering stations over the switched communication network.
- Character or Bit Service. The network control program is interrupted whenever a character or a bit arrives over a communication line. The type of scanner installed determines whether the interrupt occurs for each bit or for each character. When the interrupt occurs, the program moves the character or bit into a buffer.
- Control Character Insertion and Deletion. The network control program inserts control characters at the beginning and end of each block of data when transmitting to a station and deletes them when receiving from a station.
- Determining to which remote controller (if any) a block is to be sent.
- Controlling message traffic between local and remote controllers. This includes transmitting program load modules to remote controllers and passing storage dump data from remote controllers to the access method.
- Character Code Translation (BSC and start-stop lines only). As data arrives from a station, the network control program automatically translates it from transmission code into EBCDIC. Likewise, EBCDIC data is translated automatically into transmission code before being transmitted to a station.
- Dynamic Buffering. The network control program allocates buffers from controller storage as it receives data from a station or from the host processor. When it accumulates an entire block of data (regardless of whether the last buffer is filled), it transfers the data to the host processor.
- Speed selection. Speed selection allows the network control program (versions 2 and 5) to change the transmission rate on a line equipped with IBM 3872 or 3875 modems. A command from the access method specifies whether the normal (high) rate or (low) rate is desired. (A communication line whose performance has become too degraded for satisfactory transmission at the normal rate can often transmit satisfactorily at the lower rate.)

Error Recording and Diagnostics

The network control program maintains several types of error records and provides display capabilities for diagnostic purposes. These include:

- Hardware- and Program-Check Recording. The program keeps a record of hardware and program checks, transferring the information to the host processor whenever possible. If transfer is impossible (for example, if the channel adapter fails), the program displays the type of check on the control panel.
- Permanent Line Error Recording. If normal error recovery procedures fail to recover from a transmission error (including local/remote communication link errors), the network control program transfers a record containing information about the error to the host processor.
- Statistics Recording. The program maintains for each teleprocessing unit a count of the number of I/O operations and the number of temporary errors that occur for that unit.
- Dynamic Panel Display. This permits the operator to display storage areas, register contents, or control information on the control panel.

Optional Functions

Many of the network control program functions are optional; they may be performed instead by the host access method, or they may be omitted entirely. You select the options that meet your needs when you generate the program. Some options are automatically included in the program unless you specify that they are to be omitted. Others are omitted unless you specify that they are to be included. The following functions are optional.

Block Handling Functions

For binary synchronous and start-stop communications, the network control program can process blocks of data from either the station or the host processor via optional programs called *block handling routines.* These routines are not available in NCP 5 for data going to or coming from an SDLC station. You can select the following block handling functions:

- Date and/or time insertion
- Correction of text incorrectly entered from a station

Additional block handling functions are possible through routines that you write and assemble with the controller assembler. These routines are included in the program by coding a generation macro provided for that purpose.

Block processing is described in more detail in the section, "Block Handling Macros", in Chapter 3 of this publication.

Error Recovery and Diagnostics

- Critical Situation Notification (BSC and start-stop stations only). The network control program can notify stations when the host processor, channel, or local/remote communication link fails. You define the message to be sent to stations when a critical situation arises.
- Address Trace. The operator can request through the 3704 or 3705 control panel that the network control program record the contents of four variables (storage areas and/or registers) when a certain address in controller storage is accessed. This provides a dynamic trace facility for diagnostic purposes.
- Checkpoint/Restart (NCP 1 and NCP 2 only). The network control program works with the host access method to provide the checkpoint/restart facility. The program generates checkpoint records when they are requested by the access method. The access method then consolidates and stores the records.
- Online Terminal Tests. Online terminal testing (OLTT) facilities are available through the controllers. The network control program provides support for the

OLTT functions by recognizing test requests from teleprocessing units and executing test routines constructed by an OLTT program in the host processor.

- Online Line Testing (NCP 5 only). Online line testing (OLLT) capabilities are available in NCP 5 for SDLC communication lines. The NCP executes test routines constructed by an executive program in the host processor.
- Pause-Retry. When a transmission error occurs, the network control program tries to retransmit the data after an interval that you specify. You also specify the maximum number of retries for each station. This function is included for all stations unless you specify that no retries are to be made.
- Switched Network Backup. For certain types of BSC and start-stop stations, you can specify an alternate path for communication over the switched communication network to be used if the primary point-to-point communication line encounters an error from which normal error recovery procedures fail to recover.
- Manual Switched Network Backup (NCP 2 and NCP 5 only). This facility, an extension of the switched network backup facility mentioned above, allows the console operator to call a station upon being informed that the regular leased communication line to the station has failed. He enters a console message identifying the station to be contacted, and receives in response the identification of the switched backup line. Placing the call and transmission of data then occur as described below for manual dial operation. Data transmission continues over the backup line until the console operator re-establishes the regular leased line connection. Manual switched network backup is for use when automatic switched network backup is not available.
- Alternate Switched Operation for Local/Remote Communication Links (NCP 5 only). For each remote controller connected to the local controller by a point-to-point communication link, NCP 5 may change to a half-duplex link in the switched communication network if the regular local/remote communication link fails. (A separate switched alternate communication link is required for each remote controller.) The throughput capacity of the half-duplex communication link may be less than that of a regular duplex local/remote communication link operating at the same speed.

Miscellaneous Options

- Channel Delay Feature. This option allows you to specify an interval, in increments of 100 milliseconds, to be observed before the network control program presents Attention status to the channel. If a time delay is specified, data arriving from the stations is stored in the network control program buffer pool until the interval elapses. Then all the stored data can be transferred across the channel with only one interrupt to the host processor, thus decreasing host processor overhead. If no time delay is specified, each block of data is transferred as soon as it is processed by the network control program, requiring more frequent interrupts to the host processor. If the network control program receives enough data to fill all the allotted buffer space in the host processor before the specified interval elapses, it presents Attention to the channel immediately.
- Binary Synchronous Identification Verification. This feature is available for certain BSC stations that communicate over the switched communication network. You provide a list of valid IDs for communication lines on which ID verification is to be used. The NCP compares the ID received against those in the list and allows the station to connect if a match is found. If no match is found, the NCP can pass the information to the access method in the host processor, or it can break the connection, at your option. The ID verification feature provides the option of keeping some IDs in the controller (for example,

those of the more active stations) and some in the host processor (those of the less active stations). Or ID verification can be done entirely by the host access method.

- Multiple Terminal Access (MTA). This option, available for certain low-speed, start-stop terminals, allows the controller to communicate with dissimilar types of terminals over the same switched communication line. When a terminal calls the controller over the MTA line, the MTA option identifies the type of terminal and the transmission code used. The following terminal types are supported by this option:

  IBM 1050 Data Communication System
  IBM 2740 Communications Terminal (Basic)
  IBM 2740 Communications Terminal (Transmit Control)
  IBM 2740 Communications Terminal (Transmit Control with Checking)
  IBM 2740 Communications Terminal (Checking)
  IBM 2741 Communications Terminal
  Terminals using CPT-TWX (models 33 and 35) code (at a line speed of 110 bps)

  The terminal types, code combinations, and communication lines to be used for multiple terminal access are specified as parameters in the program generation language.

- Manual Dial Operation (NCP 2 and NCP 5 only). This is for use when automatic calling is not available. Upon receiving a command to contact a station, the network control program, via the access method, sends the console operator a message instructing him to make the call. After the operator establishes the call, he places the communication line in data mode. The program can then communicate with the station.
- Carriage Return Delay (NCP 2 and NCP 5 only). This option, available for certain start-stop terminals, causes the network control program to pause momentarily before starting a write operation that immediately follows a read operation from the terminal. This prevents random printing during the return motion of the terminal's printing mechanism by allowing time for the printing mechanism to return to the left margin.
- Monitor Mode (NCP 2 and NCP 5 only). When this option is selected for a communication line, the network control program monitors the line during input and output operations and between commands for an Attention signal sent by the terminal or a disconnect condition, the NCP notifies the host access method.

Dynamic Control Functions

The network control program recognizes commands from the host access method to dynamically change certain parameters of the teleprocessing subsystem. Some of the dynamic control functions are standard; others are included in or excluded from the program by specifying them at program generation time. The dynamic control functions include:

- Activation and deactivation of communication lines. Commands from the access method request the program to activate or deactivate one or more communication lines attached to the controller. In NCP 1 and NCP 2, the deactivation facilities allow you to perform an orderly closedown of the teleprocessing network.
- Displaying any 32 contiguous bytes of controller storage (NCP 1 and NCP 2 only). The requested bytes are sent to the host processor.
- Requesting the status of a communication line.

- Requesting the status of a teleprocessing unit (NCP 1 and NCP 2 only).
- Switching channel adapters (NCP 1 and NCP 2 only). In a local 3705, the network control program can support two type 2 or type 3 channel adapters attached to two different CPUs. This control function causes the program to switch to the secondary channel adapter upon receipt of a command from the host access method.
- Replacing ID characters and polling and addressing characters for BSC and start-stop teleprocessing units.
- Changing the order in which teleprocessing units on a multipoint BSC or start-stop communication line are polled and addressed.
- Changing the number of consecutive times teleprocessing units on a multipoint BSC or start-stop communication line can respond negatively to polling before the line is rescheduled for other operations.
- Altering the sequence of network control program commands for a particular teleprocessing unit.
- Changing the block handling routines for data associated with a BSC or start-stop teleprocessing unit.
- Setting the time and date in the controller.
- Changing the maximum number of data transmissions between the host processor and a teleprocessing unit on a multipoint BSC or start-stop line before the network control program tries to service other TP units on the line.
- Turning off the power at a remote controller by command from the access method (NCP 5 only).

Chapter 5: Emulation Program Concepts

The emulation program (EP) allows a local 3704 or 3705 to operate as an IBM 2701 Data Adapter Unit, an IBM 2702 Transmission Control, an IBM 2703 Transmission Control, or any combination of the three. The emulation program allows many programs written for support of the 2701, 2702, and 2703 to operate with the communications controller with no modification. They include IBM Type I access methods that support the 2701, 2702, and 2703, as well as IBM Type II and Type III programs and user-written programs that interface with the 2701, 2702, and 2703 in a manner equivalent to IBM Type I access method programs. Programs that involve timing dependencies and support of certain special and custom features may have to be changed.

The emulation program requires that a type 1 channel adapter be installed in the controller for attachment to a System/360 or System/370 byte-multiplexer channel. All models of the 3704 and the 3705 have enough storage to accommodate small emulation program configurations, but larger configurations require more than the minimum amount of storage.

The emulation program in conjunction with the type 1 CA permits the use of the same control sequences and data transfers as do the 2701, 2702, and 2703. It also provides most of the standard functions of these control units. Not supported are the parallel data adapter, synchronous data adapter type 1, the programmable two-processor switch, two-channel attachment, six-bit transcode, 230,400 bps synchronous speed, selector channel attachment, direct attachment of the IBM 1032 Digital Time Unit, and the IBM 2712 Remote Multiplexer attachment features.

In addition to the standard 2701-2702-2703 functions, the emulation program also supports certain RPQs (requests for price quotation) for these control units.

In emulation mode, the 3705 can attach up to 255 communication lines for half-duplex operation at speeds from 45.5 bps to 50,000 bps. The 3704 can attach up to 32 communication lines at speeds from 45.5 bps to 50,000 bps. The actual number of lines that can be attached depends upon the specific configuration of the teleprocessing subsystem. Each line attached to the controller in emulation mode requires a nonshared subchannel address on the byte-multiplexer channel.

Appendix B lists the terminals, control units, and computers supported by the 3704 and the 3705 over communication lines in emulation mode, when the controller is executing an emulation program or a network control program with the partitioned emulation programming (PEP) extension.

The *Emulation Program Generation and Utilities* manual explains how to code program generation statements to generate an emulation program suited to the needs of your installation. (See Appendix D for a description of this publication.)

Chapter 6: Partitioned Emulation Programming Extension Concepts

The network control program, version 2 or 5, is capable of operating communication lines in emulation mode as well as in network control mode. This capability is available only for NCPs running in local controllers.

The partitioned emulation programming (PEP) extension of the network control program, versions 2 and 5, allows the communications controller to operate as an IBM 2701, 2702, or 2703 transmission control unit (or any combination of the three) for certain lines, while performing network control functions for others. (The controller must be attached to the System/370 by a type 1 channel adapter or by a type 1 and a type 2 or type 3 channel adapter.)

During program generation you specify each communication line as being operable in network control mode, or in emulation mode, or both. If you specify operation in either mode, the line always operates in that mode. But if you specify operation in both modes, you can change the line from one mode to the other upon command from the host processor. Program generation language parameters specify the mode in which the line is to be placed initially when the network control program is loaded.

The partitioned emulation programming (PEP) extension allows many programs written for support of the IBM 2701, 2702, and 2703 to operate with the controller without modification. These programs include IBM Type I access methods that support the 2701, 2702, and 2703 as well as IBM Type II and III programs and user-written programs that interface with these units in a manner equivalent to Type I access method programs. Programs that involve timing dependencies and support of certain special and custom features may have to be changed.

Advantage of the PEP Extension

The principal advantage of the PEP extension is that it allows concurrent operation of existing application or access method programs, designed to communicate with a 2701, 2702, or 2703, and new (or converted) application programs designed to communicate with NCP 2 or NCP 5.

With concurrent operation, you need not convert all existing application or access method programs before realizing the benefits of operating communication lines in network control mode rather than in emulation mode. You may convert programs gradually, over any desired period. As conversion of each program is completed, you may change the communication lines used by that program from emulation mode to network control mode. Spreading the conversion process over an extended period allows each program to be more thoroughly tested than if all programs had to be converted at once. However, the sooner you convert all programs, the sooner you will realize the full benefits of operating all lines in network control mode.

You may wish to defer conversion of any existing application programs until new application programs, designed for use with the network control program, are completed. This may be advantageous when installation of the controller coincides with the development of new applications for the teleprocessing subsystem. You can then concentrate on developing the new application programs.

Channel Attachment

A network control program with the PEP extension requires a type 1 channel adapter in the communications controller for attachment to a System/370 byte-multiplexer channel.

If the controller has a type 1 adapter, the channel appears to the access method as a number of separate subchannels, one for each communication line that is to operate in emulation mode, and a single subchannel for all lines that are to operate in network control mode.

Data interchanges on the emulation subchannels have priority over data interchanges on the network control subchannel. The throughput of communication lines in network control mode is affected by such factors as (1) the amount of message traffic in the teleprocessing network, and (2) the relative proportion of lines in emulation mode and network control mode.

If the controller is a 3705 equipped with a type 2 or a type 3 channel adapter as well as a type 1 channel adapter, the type 1 adapter handles only data interchanges for lines in emulation mode, and the other adapter handles all data interchanges for lines in network control mode.

When two channel adapters are used with NCP 5 or a later version of the NCP, they can be attached to two separate CPUs. (This capability is referred to as *two-CPU PEP.*) The lines operating in NCP mode are controlled by VTAM in one CPU over the type 2 or type 3 channel adapter. The lines operating in EP mode are controlled by some other access method in the second CPU over the type 1 CA.

Each communication line to be operated in emulation mode must occupy one of a sequence of contiguous subchannel addresses, all of which are reserved for the controller. Not all lines represented by addresses in the sequence need operate in emulation mode. However, the emulation subchannel corresponding to a line is active only when that line is operating in emulation mode.

Control Sequences, Data Transfers, and Functions

A network control program with PEP, in conjunction with the type 1 channel adapter, permits the use of the same control sequences and data transfers as do the IBM 2701, 2702, and 2703. It also provides most of the standard functions of these units. Not supported are the parallel data adapter, synchronous data adapter type 1, the programmable two-processor switch, two-channel attachment, six-bit transcode, 230,400 bps synchronous speed, selector channel attachment, direct attachment of the IBM 1032 Digital Time Unit, and the IBM 2712 Remote Multiplexer attachment features.

Communication Lines and Stations Supported

A 3705 that is to execute a network control program with PEP can attach up to 352 communication lines for half-duplex operation at speeds from 45.5 to 50,000 bits per second. Of these, up to 255 can be in emulation mode because of a CPU subchannel limitation.

A 3704 that is to execute a network control program with PEP can attach up to 32 communication lines for half-duplex operation at speeds from 45.5 to 50,000 bits per second.

The actual maximum number of communication lines the program can support depends upon the specific configuration of the teleprocessing subsystem and upon the relative proportion of lines operating in network control mode and emulation mode.

A network control program with PEP can communicate in network control mode with the types of stations listed in Appendix A, and in emulation mode with those listed in Appendix B.

Chapter 7: The 3705-II and 3705 Enhancement Features

A significant addition to the line of IBM Communications Controllers is the introduction of the IBM 3705-II Communications Controller, with models E, F, G, and H. This enhanced model of the 3705, in combination with several new features, provides improvements in speed, throughput, storage availability, and cost over the IBM 3705-I (referred to elsewhere in this publication simply as the IBM 3705).

Four new features are introduced with the 3705-II. They are (1) monolithic (FET-Field Effect Transistor) storage, (2) the type 3 communication scanner, (3) the type 4 channel adapter, and (4) line set 1S for use with LIB type 1. All of these features are field installable. Except for monolithic storage, they are all available for the 3705-I as well as for the 3705-II.

New versions of the network control program/VS (NCP/VS) and the emulation program (EP) and EP/VS provide the programming support for the 3705-II and the new features. A new NCP, PEP, or EP generation is required for operation in any 3705-II machine or for operation in a 3705-I with any of the new features installed.

This chapter covers the functions of the 3705-II and the enhancement features, the various configurations supported with the new features, and the new programming support. The information presented here is to be used for *planning purposes only.* The other chapters of this manual remain valid for previous program and hardware releases.

The IBM 3705-II Communications Controller

The IBM 3705-II consists of up to four frames: a base module and three expansion modules. The base module alone is designated as model E; with one expansion module it is designated model F; with two expansion modules, model G; and with three expansion modules, model H. The 3705-II models are further defined according to the amount of storage installed. Figure 17 lists the 32 models with their corresponding storage capacities.

3705-II Model	*Amount of Monolithic Storage (Bytes)**
E1-F1-G1-H1	32K
E2-F2-G2-H2	64K
E3-F3-G3-H3	96K
E4-F4-G4-H4	128K
E5-F5-G5-H5	160K
E6-F6-G6-H6	192K
E7-F7-G7-H7	224K
E8-F8-G8-H8	256K

* Monolithic storage is installed in the base module only.

Figure 17. 3705-II Storage Increments by Model

The 3705-II base module contains a central control unit with a cycle time of 1.0 microsecond (μs), an improvement of 0.2μs over the 3705-I; a control panel like that on the 3705-I; and at least 32K bytes of monolithic storage (up to a maximum of 256K bytes). It also contains provisions for mounting a channel adapter, a communication scanner, and LIBs and line sets. The expansion modules contain provisions for mounting a channel adapter (up to a maximum of two per 3705-II), a communication scanner (one per module), and additional LIBs and line sets. The expansion modules contain no storage. The functions of the central control unit and the control panel are the same as those described in Chapter 2 for the 3705-I.

The 3705-II must contain 32K bytes of monolithic storage (described later in this chapter). Additional monolithic storage is available in the increments shown in Figure 17. In addition to monolithic storage, the 3705-II supports the following features:

- Type 1 channel adapter with two-channel switch (described in Chapter 2)
- Type 2 channel adapter with two-channel switch (described in Chapter 2)
- Type 3 channel adapter (described in Chapter 2)
- Type 4 channel adapter with two-channel switch (described later in this chapter)
- Type 2 communication scanner (described in Chapter 2)
- Type 3 communication scanner (described later in this chapter)
- LIB Types 1-12 and available line sets (described in Appendix C and later in this chapter)

3705 Enhancement Features

The features described in the following sections are available, except as noted, on both the 3705-I and the 3705-II. Figure 18 shows the permissible combinations of the type 3 scanner and the type 4 CA with the other scanner and channel adapter types available for the 3705-I; the combinations of features shown in Chapter 2 (Figures 7 and 8) are also still valid for the 3705-I. Figure 19 shows the permissible combinations of communication scanners and channel adapters available for the 3705-II.

Monolithic Storage

One 32K byte increment of monolithic storage is always installed in the 3705-II base module; additional 32K byte increments are available in the various models, giving a range of installed storage from 32K to 256K bytes (see Figure 17). Monolithic storage cannot be installed in 3705-II expansion modules or in any module of the 3705-I. However, monolithic storage can be field-installed, provided that any 3705-I is first converted to a 3705-II.

Monolithic storage has four advantages over the core storage used in the 3705-I: (1) it is faster (it has a cycle speed of 1.0μs as compared to 1.2μs for 3705-I core storage); (2) it is all contained in the base module instead of being spread through four modules; (3) it is more economical; and (4) it has double-bit error detection and single-bit error correction.

	Permissible Combinations	*Base Module*	*First Expansion*	*Second Expansion*	*Third Expansion*
	Type 4 CA and	1	1*	—	—
	Type 2 Scanner	1	1	1	1
**	Type 4 CA and	1	—	—	—
	Type 2 or Type 3 CA	—	1	—	—
	and Type 2 Scanner	1	1	1	1
	Type 4 CA and	1	1*	—	—
	Type 2 Scanner and	1	1	1	1
			or	or	or
	Type 3 Scanner	—	1	1	1
**	Type 4 CA and	1	—	—	—
	Type 2 or Type 3 CA and	—	1	—	—
	Type 2 Scanner and	1	1	1	1
			or	or	or
	Type 3 Scanner	—	1	1	1
***	Type 2 or Type 3 CA	1	1	—	—
	and Type 2 Scanner and	1	1	1	1
			or	or	or
	Type 3 Scanner	—	1	1	1

* Second type 4 CA can operate with EP and PEP systems only. In a PEP system, the NCP portion can operate with only one of the type 4 CAs.
** Operation over both channel adapters allowed with PEP systems only.
*** Combination allowed in NCP systems only.

Note: Combinations shown in Figure 8, Chapter 2, are also still valid for the 3705-I.

Figure 18. Permissible Combinations of Features with the Type 3 Scanner and Type 4 Channel Adapter in the 3705-I

Type 3 Communication Scanner

The type 3 communication scanner provides for the attachment of BSC communication lines that operate with either the EBCDIC or the ASCII transmission code (in transparent or nontransparent mode) or for the attachment of SDLC communication lines. In the 3705-I, models B, C, and D, one type 3 scanner can be installed in each expansion module, with a maximum of three in model D; in these models, a type 2 scanner must be installed in the base module. In the 3705-II, one type 3 scanner can be installed in the base module and one in each expansion module, with a maximum of four in model H. A type 3 scanner is not allowed in the base module of the 3705-I.

Type 3 scanners can be mixed with other scanners and channel adapters in the combinations shown in Figures 18 and 19. Type 3 scanners cannot be installed with a type 1 scanner or a type 1 CA.

When installed in the 3705-II base module, the type 3 scanner can have up to 48 half-duplex, synchronous communication lines physically attached; when installed in an expansion module of the 3705-I or 3705-II, it can have up to 64 half-duplex, synchronous lines attached. The actual number of lines that can operate successfully with the type 3 scanner depends upon many factors, including: line speed, whether the lines are capable of half-duplex or duplex data transmission, and which control program is handling the lines.

	Permissible Combinations	*Base Module*	*First Expansion*	*Second Expansion*	*Third Expansion*
	Type 1 CA and Type 2 Scanner	1 1	— 1	— 1	— 1
*	Type 1 CA and Type 2 or Type 3 CA and Type 2 Scanner	1 — 1	— 1 1	— — 1	— — 1
**	Type 2 or Type 3 CA (any combination) and Type 2 or Type 3 Scanner (any combination)	1 1	1 1	— 1	— 1
	Type 4 CA and Type 2 or Type 3 Scanner (any combination)	1 1	1*** 1	— 1	— 1
*	Type 4 CA and Type 2 or Type 3 CA and Type 2 or Type 3 Scanner (any combination)	1 — 1	— 1 1	— — 1	— — 1

* Operation over both channel adapters allowed with PEP systems only.
** Combination allowed in NCP systems only.
*** Second type 4 CA can operate with EP and PEP systems only. In a PEP system, the NCP portion can operate with only one of the type 4 CAs.

Figure 19. Permissible Combinations of Communication Scanners and Channel Adapters in the 3705-II

The type 3 scanner can operate with the following line interface bases (LIB): LIB Type 1, LIB Type 8, LIB Type 9, and LIB Type 10. Only the line sets that support synchronous line controls can be used with the type 3 scanner. See Appendix C and the next section of this chapter for a description of the LIBs and line sets.

The type 3 scanner can operate with either the network control program or the emulation program. The scanner interrupts the 3705 control program after receiving or sending an entire buffer of data rather than after each bit or byte. The length of the data to be transferred is provided dynamically by the control program. For the network control program, the maximum buffer length is 255 bytes; for the emulation program, the buffer length may be 4, 8, 16, or 32 bytes.

An added capability of the type 3 scanner is code translation via hardware for BSC lines operating in network control mode. The scanner translates from ASCII to EBCDIC when receiving from the line and from EBCDIC to ASCII when transmitting to the line.

Line Set Enhancements

Line sets 1D and 1H have been enhanced for use with both the 3705-I and the 3705-II, and a new line set, line set 1S, is available for use with LIB Type 1. These new features are described below.

Line Set 1D

Line set 1D now provides for the attachment of communication lines at speeds up to 9600 bps. The remaining capabilities of this line set are as described in Appendix C.

Line Set 1H

Line set 1H now provides for the attachment of communication lines at speeds up to 9600 bps. The remaining capabilities of this line set are as described in Appendix C.

Line Set 1S (Common Carrier 56,000 bps Attachment)

This line set provides for the attachment of one CCITT V.35 type interface to be used on a communication facility at 56,000 bps. This line set is available only in the United States and Canada.

Type 4 Channel Adapter

The type 4 channel adapter is primarily for use with the emulation program to provide improved throughput over the type 1 CA when operating with a type 3 scanner. It can also be used with the network control program and with systems operating in partitioned emulation (PEP) mode.

The type 4 channel adapter can transfer a maximum of 32 bytes of data across the channel during each data transfer burst. The emulation program user can choose through an EP generation option the number of bytes of data the EP is to pass to the channel adapter each time the appropriate level 3 channel adapter interrupt occurs. In this case, the user has a choice of 4, 8, 16, or 32 bytes. The network control program has no generation option to control the amount of data passed to the channel adapter; it always transfers four bytes.

Up to two type 4 CAs can be installed in a 3705-I or 3705-II: one in the base module and one in the first expansion module. A type 4 CA in the base module can be combined with a type 2 or type 3 CA in the first expansion module for operation in partitioned emulation mode. In this case, the type 4 CA handles data transfers for lines in emulation mode and the type 2 or type 3 CA handles data transfers for lines in network control mode. The two channel adapters in a PEP system may be attached to the same or different CPUs. A type 4 CA cannot be combined with a type 1 CA or a type 1 scanner. Figures 18 and 19 summarize the permissible combinations of the type 4 CA with other channel adapters and scanners.

Each type 4 CA can have a two-channel switch. The characteristics of the two-channel switch are described in Chapter 2.

Programming support for two type 4 CAs is provided only for communication lines operating in emulation mode in either a PEP or EP system. This support is discussed later in this chapter under "Multiple Subchannel Support."

Network Control Program Support for the 3705 Enhancement Features

The network control program/VS, version 5, adds new code in program levels 2 and 3 to support operation of the type 3 scanner. It also modifies the line trace, the panel test, and the online tests as required to support the type 3 scanner. This version of the NCP does not support intermediate block checking mode (ITB mode) while in transparent text on BSC lines attached through a type 3 scanner. It also does not support the 3705 as a tributary station attached to a multipoint BSC line through a type 3 scanner.

The type 4 channel adapter requires some modifications to the type 1 CA support code in an NCP with the PEP extension to support greater than four-byte data transfers to the channel adapter for lines operating in EP mode. Only four-byte data transfers are supported for lines in NCP mode on a type 4 CA.

NCP/VS communicates with VTAM operating under DOS/VS, OS/VS1, and OS/VS2.

Emulation Program Support for the 3705 Enhancement Features

The emulation program adds code to support the type 3 communication scanner (for BSC lines only) and the type 4 channel adapter. This version of the EP also modifies the line trace and the panel test to support the type 3 scanner. In addition, it supports BSC lines using the transparent ASCII code when attached to a type 3 scanner. In previous versions of the EP, this feature was available only as a PRPQ (Programming Request for Price Quotation). This version of the EP does not support the 3705 as a tributary station on a multipoint BSC line attached through a type 3 scanner.

The emulation program with support for the enhancement features operates with access methods under the virtual operating systems—DOS/VS, OS/VS1, and OS/VS2—and under OS/MFT and OS/MVT systems. Type 4 CA support may necessitate changing certain access method parameters, such as I/O buffer size, to handle timing changes resulting from changes in channel transfer widths.

The equivalent of the new EP support is provided for communication lines operating in emulation mode under a PEP system when the NCP portion is at the level described above.

Multiple Subchannel Support

An optional capability provided by the new version of the emulation program supports two type 4 channel adapters attached to the same or different host processors. This capability is called *multiple subchannel line access* (MSLA). As part of this support, the EP can switch control of communication lines from one access method to another, either within the same host processor or between different host processors. This capability is accomplished by assigning multiple subchannel addresses on the same or different channels to a single communication line during EP generation. Thus two access methods have access to the same communication line over separate subchannels.

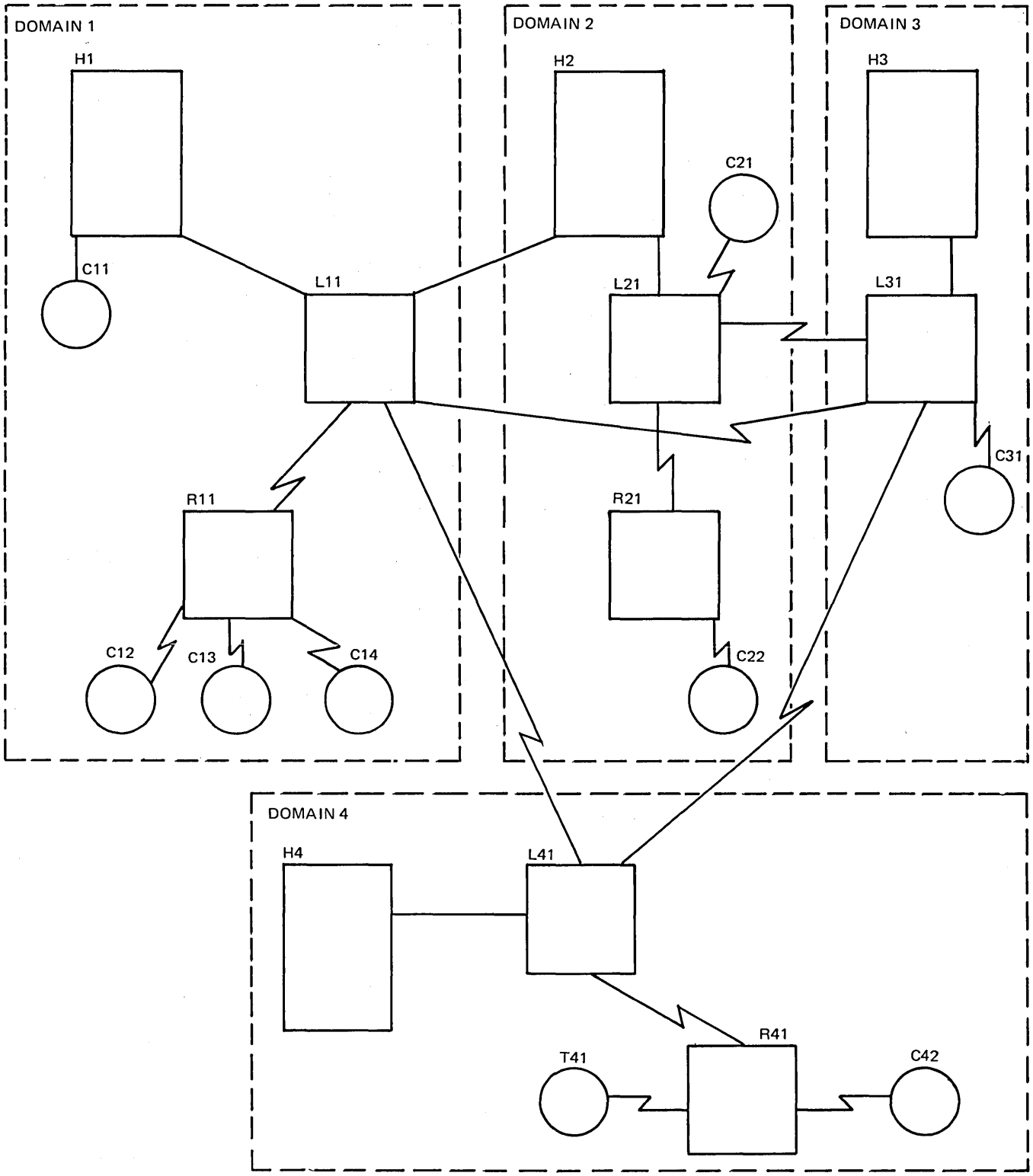
The support of multiple subchannels for one communication line provides the following advantages to the user:

- Load balancing—The user can switch communication lines from one host processor to the other during busy periods to balance the load on the processors.
- Configuration backup—The user can switch control of a group of lines assigned to one host processor to the other host processor if the host processor, access method, or channel fails.
- Communication line sharing—Two access methods in the same or different host processors can share communication lines (for example, for two different applications). The sharing is alternate, not concurrent.

  In this mode of operation, the first access method to try to use a shared line gets control of the line and keeps control until it (the same access method) releases the line by disabling it. Once the line is free, the other access method (or the same one) can assume control of the line. If the second access method tries to gain control of the line while it is being used by the first, the attempt is rejected, and the operator must intervene to retry the operation when the line is free.

  Under certain circumstances, the emulation program allows the operator to switch control of a line, using the 3705 control panel, even though the controlling access method has not released the line.

Two type 4 channel adapters can also be used with a PEP system, but only the lines operating in EP mode can use the multiple subchannel support. Only one of the two type 4 CAs can have an NCP subchannel.



H = Host
L = Local Communication Controller
R = Remote Communication Controller
C = Cluster Controller
T = Terminal

Figure 20. Sample SNA Network Configuration

Chapter 8. NCP Support for TCAM and VTAM Networks

A version of the network control program, known as advanced communications function for the network control program/virtual storage (ACF/NCP/VS), is available to work with TCAM or VTAM. ACF/NCP/VS is a *program product* (a licensed program) that provides advanced communications function networking, in accordance with the concepts of systems network architecture (SNA). This chapter describes the networking support that the NCP program product provides. It also describes several hardware enhancements for the 3705-II. The program-product version of NCP is available only for the 3705-I equipped with a type 2 or type 3 communications scanner and for the 3705-II.

The networking capabilities of NCP are particularly appropriate for users who wish to interconnect several locations to share resources and reduce communication costs. Formerly, a network included only a single host computer and a variety of communications controller, cluster, and terminal nodes. The NCP's networking function allows multiple single-host networks to be combined into one large network. In the context of the large network, the original networks are treated as *domains,* each managed by a System Services Control Point (SSCP). End users, whether located at host or cluster/terminal nodes, can have access to the resources of other domains in the network. For a thorough description of networking, refer to *An Introduction to Advanced Communications Function,* GC30-3033.

The functions provided by NCP for networking include:

- interconnection
- availability
- serviceability

Interconnection

The interconnection function allows an NCP to communicate with another NCP over an SDLC link. This interconnection support is similar to the currently existing support of communication between a local NCP and a remote NCP. For networking, however, interconnection refers only to communication between local NCPs in different domains. In Figure 20, the link between the NCPs in communications controllers L11 and L31 illustrates a networking interconnection.

Also included in interconnection support is an expanded data routing capability that allows data to pass through an NCP to another domain without intervention from the NCP's controlling host. For example, to establish a session between host node H3 (Figure 20) and an LU in cluster node C12, host node H1 must assist. However, after the session has been established, data can pass between the two with no further assistance from host node H1.

Networking support for pre-SNA devices is also provided. This support allows the same kind of cross-domain routing of data for pre-SNA devices as for SNA devices.

Availability

The availability function allows most network operations to continue when some portion of the network becomes inoperative. With this capability, an NCP can continue to support existing cross-domain sessions that use nonswitched lines, even if the NCP's controlling SSCP fails. It can also free the nonswitched-line resources of a failing SSCP while leaving unaffected the resources not controlled by the failing SSCP. (All switched-line resources connected to an NCP are disconnected when the NCP's SSCP fails.) The freed resources

may be recovered by either the failed SSCP when it is restored or by another SSCP that is operational. Finally, the NCP can notify SSCPs when it loses its connection to any other subarea in the network. (A *subarea* is either a host with its associated LUs, PUs, and SSCPs, or a local or remote communications controller with its associated LUs, PUs, and terminals.) This function enhances integrity in a multiple-domain environment because it allows notification to applications of loss of connectivity with their session partners.

In Figure 20, if the SSCP in host H1 were to fail while the SSCP in host H3 and the LU in cluster node C12 were in session, the NCP in communications controller L11 would continue to support the session. Furthermore, it would free those other resources of the failed SSCP that it controlled (cluster nodes C13 and C14). The freed resources would then be available to the other SSCPs in the network. Alternatively, they would be available to the failed SSCP, if it were restored. If any of the other SSCPs (in hosts H2, H3, or H4) attempts to initiate a session through NCP L11, it will be informed of the failure of SSCP H1 coincidently with the establishing of the session.

The availability function also includes inbound (secondary-to-primary) pacing. This allows the host to control the rate of data flow from terminals, thereby alleviating possible input data congestion.

Serviceability

The serviceability function allows an NCP that has been designated as "secondary" during system generation to support a test command to verify the operation of a cross-domain SDLC link. This capability already exists in "primary" NCPs for testing the primary-to-secondary link. Serviceability support also provides the capability to trace concurrently the activity on up to eight lines attached to a single NCP.

Serviceability also includes two new panel functions: The dynamic on/off channel adapter trace and the dynamic data store. Dynamic on/off channel adapter trace allows the 3705 operator to activate or deactivate the channel trace function via the control panel while the NCP is operating. The dynamic data store allows the 3705 operator to store single bytes, halfwords, or 18-bit words from the control panel without stopping the 3705.

Multiple Input/Output Channel Support

Another function of the NCP, but one not directly related to SNA networking, is its ability to communicate over as many as four host I/O channels simultaneously. The channels may be from the same host or from up to four different hosts. Similarly, the communication may be with either identical or different access methods (SSCPs). To use this new function, the 3705 must be equipped with the following channel adapters: two type 2s or type 3s; a type 2 and a type 3; up to two type 4s (for a 3705-I) or up to four type 4s (for a 3705-II). No more than two host channels may communicate with an emulation program that is sharing the 3705 with an NCP. Figure 21 illustrates the NCP/EP combinations that can be used when the maximum number of I/O channels are present.

Use of the NCP's multiple channel support allows a user to reduce his costs by reducing his hardware requirements. During generation, the multiple-channel 3705 is defined to each controlling host as being in its domain. This multiple definition necessitates operator communication between hosts so that only one host attempts to load the 3705. (Loading is possible via any channel, from any host.)

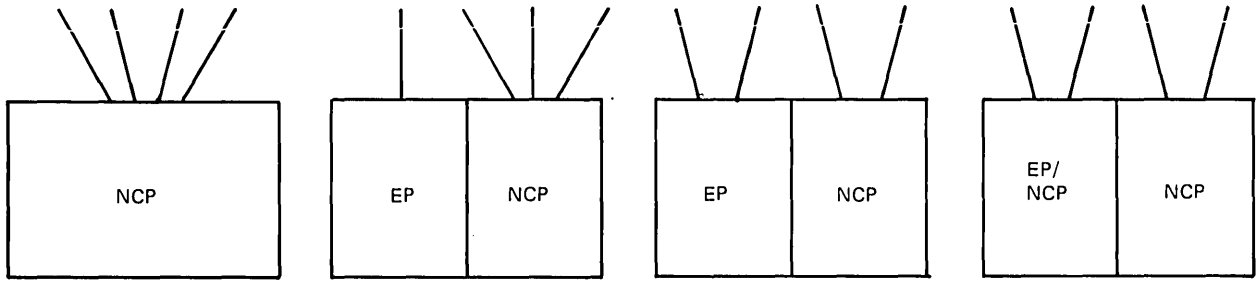


Figure 21. Permissible NCP/EP Multiple Channel Adapter Combinations

The user may allocate the resources attached to the 3705 in either of two ways:

- The NCP generation can explicitly specify ownership of each resource by only one host. In this case, resources in the separate domains are fully shareable between domains. The owning host manages the allocation of resources. For example, in Figure 22, assume that C21 and LU5 are defined as belonging to the domain of H2. LU5 can, however, be known to H1 as a cross-domain resource, and thus be available to applications in H1.
- Resources can be defined to multiple hosts via an NCP SYSGEN. In this case, allocation (activation) is via operator coordination between hosts to determine which host will activate and own the resources. This allocation method eases an operator-controlled switchover of resources in case of host failure.

3705-II Hardware Extensions

Several capabilities have been added to the 3705-II to enhance its performance. They are:

- Type 4 channel adapter improvements
- 3705-II remote capability
- Duplex wideband line sets

The type 4 channel adapter has been modified to allow up to four type 4 channel adapters in a single 3705-II configuration. Up to two type 4 channel adapters can reside in an E model; up to four can reside in models F, G, and H. Also, the type 4 channel adapter can be attached to a selector, byte multiplexer, or block multiplexer channel of a System/370 or to a byte multiplexer channel of a System/360. Finally, the type 4 channel adapter can operate in cycle steal mode, which allows the NCP to increase the throughput of the channel adapter.

The remote program loader and remote power off features are now available for the 3705-II. The remote program loader feature can exist on the 3705-II either with type 1, 2, 3, or 4 channel adapters or without any channel adapter. Its purpose is to provide a load and dump capability over the communication line when the channel adapters are disabled. A maximum of three channel adapters may coexist on a 3705-II with the remote program loader. However, if there are three channel adapters, they must all be type 4s.

Duplex wideband communication is supported on the 3705-I and 3705-II through two line sets, 1T and 1U. Line set 1T provides for the attachment of one duplex synchronous line that has a digital interface for attachment to an external modem for up to 50,000 bps switched or nonswitched wideband facilities. Line set 1U provides for the attachment of one duplex line that has a CCITT V35 interface for attachment to an external modem for up to 56,000 bps communications facilities. For more details about line sets 1T and 1U, refer to Appendix C.

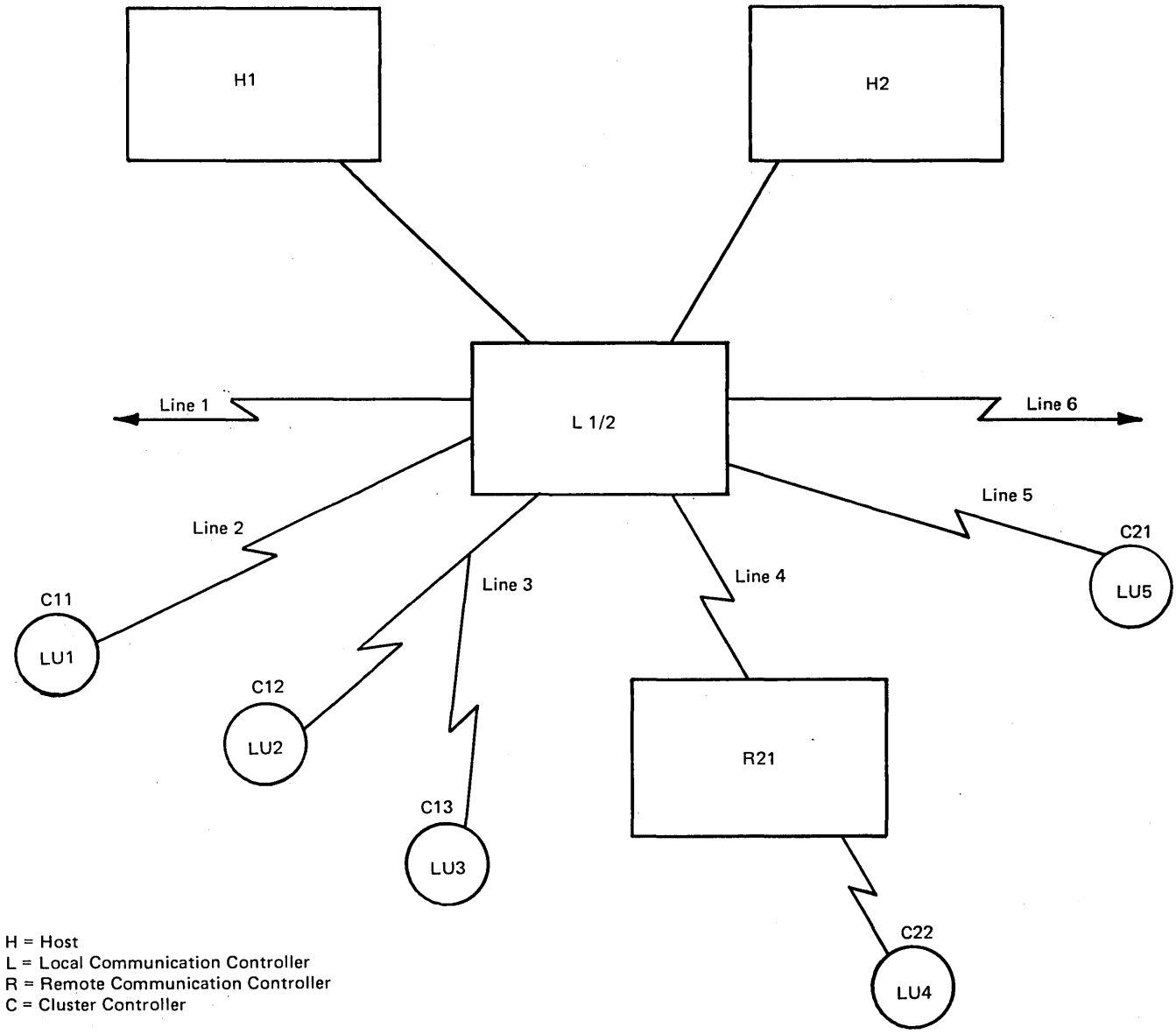


Figure 22. Multiple I/O Channel Attachment Example

Appendix A: Types of Stations Supported by the IBM 3704 and 3705 Communications Controllers in Network Control Mode

The IBM 3704 and 3705 Communications Controllers, whether local or remote, can communicate in network control mode with stations of the following types. Consult your IBM representative for the specific requirements for support of each of these stations.

Start-Stop Terminals

IBM 1050 Data Communication System
IBM 2740 Communications Terminal, Models 1 and 2
IBM 2741 Communications Terminal
IBM Communicating Magnetic Card Selectric® Typewriter

Binary Synchronous Terminals

IBM 2770 Data Communications System
IBM 2780 Data Transmission Terminal (no support for Transcode)
IBM 2972 General Banking Terminal System, Models 8 and 11
IBM 3270 Information Display System[1]
IBM 3735 Programmable Buffered Terminal
IBM 3740 Data Entry Terminal
IBM 3780 Data Communication Terminal

Synchronous Data Link Control Clusters and Terminals

IBM 3270 Information Display System [1]
IBM 3600 Finance Communication System
IBM 3614 Consumer Transaction Facility
IBM 3650 Retail Store System
IBM 3660 Supermarket System
IBM 3767 Communication Terminal
IBM 3770 Data Communication System
IBM 3790 Communication System

Transmission Control Units

IBM 2701 Data Adapter Unit (with Synchronous Data Adapter Type II)[2,3]
IBM 2703 Transmission Control (with Synchronous Terminal Control)[2,3]
IBM 2715 Transmission Control, Model 2[2]
IBM 3704 Communications Controller[4]
IBM 3705 Communications Controller[4]

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[1] Supported as a BSC terminal and, under NCP 4 only, as an SDLC terminal.

[2] BSC support only.

[3] Supported only when attached locally to an IBM System/360 or System/370.

[4] A *local* controller can communicate in network control mode with (1) one or more other local 3704 or 3705 controllers, via a binary synchronous communication line, and (2) one or more remote 3704 or 3705 controllers via a duplex or half-duplex local/remote communication link.

A *remote* controller (1) *must* communicate in network control mode with a local controller via a duplex or half-duplex local/remote communication link, and (2) *may* communicate in network control mode with one or more local 3704 or 3705 controllers via binary synchronous communication line.

Computers (BSC support only, except for System/7)

IBM System/3
IBM System/7 (supported as an IBM 2740 Communications Terminal, Model 1, with the Record Check feature, or as a System 3)
IBM System/360, Model 20 (with Binary Synchronous Communications Adapter)
IBM System/360, Model 25 (with Integrated Communications Attachment with Synchronous Data Adapter II)
IBM System/370, Model 125 (with Integrated Communications Attachment with Synchronous Data Adapter II)
IBM System/370, Model 135 (with Integrated Communications Attachment with Synchronous Data Adapter II)
IBM 1130 Computing System (with Synchronous Communications Adapter)
IBM 1800 Data Acquisition and Control System (via IBM 1826 Data Adapter Unit with Communication Adapter)

The controllers also communicate in network control mode with the following:

A. World Trade teleprinters that use CCITT No. 2 or No. 5 code on leased point-to-point communication lines.
B. Terminals using the following line control disciplines: AT&T 83B3 or WU 115A start-stop code, over point-to-point or multipoint leased telegraph lines; CPT-TWX (33/35) start-stop code over the switched communication network.

Attachment of non-IBM equipment is under the provisions of the IBM Multiple Supplier Systems Policy.

Appendix B: Types of Stations Supported by the IBM 3704 and 3705 Communications Controllers in Emulation Mode

The IBM 3704 and 3705 Communications Controllers, when attached to a host processor channel, can communicate in emulation mode with stations of the following types. Consult your IBM representative for the specific requirements for support of each of these stations.

Start-Stop Terminals

IBM 1030 Data Collection System
IBM 1050 Data Communication System
IBM 1060 Data Communication System
IBM 2260 Display Station (via IBM 2848 Display Control)
IBM 2265 Display Station (via IBM 2845 Display Control)
IBM 2740 Communications Terminal, Models 1 and 2
IBM 2741 Communications Terminal
IBM 2760 Optical Image Unit (via the IBM 2740 Communications Terminal, Model 1)

Binary Synchronous Terminals

IBM 2770 Data Communications System
IBM 2780 Data Transmission Terminal (no support for Transcode)
IBM 2970 Models 5 and 8 Banking Terminals (not available in the United States and Canada)
IBM 2972 General Banking Terminal System, Models 8 and 11
IBM 3270 Information Display System
IBM 3650 Retail Store System
IBM 3660 Supermarket System
IBM 3670 Brokerage Communication System (supported only in the United States and Canada)
IBM 3735 Programmable Buffered Terminal
IBM 3740 Data Entry Terminal
IBM 3780 Data Communication Terminal

Transmission Control Units

IBM 2701 Data Adapter Unit (with Synchronous Data Adapter Type II)[1,2]
IBM 2703 Transmission Control (with Synchronous Terminal Control)[1,2]
IBM 2715 Transmission Control, Model 2[1]
IBM 3704 Communications Controller[3]
IBM 3705 Communications Controller[3]

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[1]BSC support only.

[2]Supported only when attached locally to an IBM System/360 or System/370.

[3]A local controller can communicate in emulation mode with one or more other channel-attached 3704 or 3705 controllers via a binary synchronous communication line.

Computers (BSC support only except for System/7)

IBM System/3
IBM System/7 (supported as an IBM 2740 Communications Terminal, Model 1, with the Record Check feature; also supported as a BSC station)
IBM System/360, Model 20 (with Binary Synchronous Communications Adapter)
IBM System/360, Model 25 (with Integrated Communications Attachment with Synchronous Data Adapter II)
IBM System/370, Model 125 (with Integrated Communications Attachment with Synchronous Data Adapter II)
IBM System/370, Model 135 (with Integrated Communications Attachment with Synchronous Data Adapter II)
IBM 1130 Computing System (with Synchronous Communications Adapter)
IBM 1800 Data Acquisition and Control System (via IBM 1826 Data Adapter Unit with Communication Adapter)
IBM 3750 Switching System (not available in the United States and Canada)

The controllers also communicate in emulation mode with the following:

A. World Trade teleprinters that use CCITT No. 2 or No. 5 code on leased point-to-point, leased multipoint, or switched network communication lines.
B. Terminals using the following line control disciplines: AT&T 83B3 or WU 115A start-stop code, over point-to-point or multipoint leased telegraph lines; CPT-TWX (33/35) start-stop code over the switched communication network.

Attachment of non-IBM equipment is under the provisions of the IBM Multiple Supplier Systems Policy.

Appendix C: 3704 and 3705 Line Interface Bases and Line Sets

Line interface bases (LIB) and their associated line sets provide for the attachment of communication lines to the IBM 3704 and 3705 Communications Controllers. Several different types of LIBs and line sets are available, as listed below.

Note: The maximum number of line sets attachable to the 3704 or the 3705 depends upon the speed (data rate) of the lines, the type of channel adapters and communication scanners installed, and the mode of operation (network control mode or emulation mode). Discuss your requirements with your IBM representative to determine permissible combinations of the LIBs and line sets listed.

LIB Type 1: The LIB Type 1 provides for attachment of the following line sets. Line sets 1A, 1B, 1C, 1D, 1E, 1F, 1G, 1H, 1J, 1K, 1S, 1T, and 1U may be attached to a LIB Type 1 in a 3705. In a 3704, line sets 1A, 1B, 1C, 1D, 1E, 1F, 1H, 1L, 1M, 1P, 1Q, 1X, and 1Y may be attached to LIB Type 1 or A1; line sets 1G, 1J, and 1K may be attached only to a LIB Type A1.

1. Line Set lA (Low-Speed External Modem)—This line set provides for the attachment of two start-stop communication lines at speeds up to 1200 bps, each line having an EIA RS-232C/CCITT V.24 interface for attachment to an external modem. The IBM modems with which this line set can operate include the following:

   IBM 2711 Line Adapters
   IBM 3976 Models 1, 2, and 3 (not available in the United States and Canada)
   IBM 3977 Model 2 (not available in the United States and Canada)
   IBM 5979 L01/L02 (not available in the United States and Canada)

2. Line Set 1B (Low Speed Duplex External Modem)—This line set provides for the attachment of one start-stop duplex communication line that has an EIA RS-232C/CCITT V.24 interface, at speeds up to 1200 bps. This line set combines two communication-line ports into a true duplex data port. This line set cannot be used for a duplex line connecting a local and a remote communications controller.
3. Line Set 1C (Low Speed Local Attachment)—This line set provides for the local attachment of two IBM start-stop terminals at speeds up to 1200 bps via IBM-provided cables. Modems are not required. Total cable length may not exceed 200 feet.
4. Line Set 1D (Medium Speed External Modem)—This line set provides for the attachment of two start-stop or synchronous communication lines at speeds up to 9600 bps, each of which has an EIA RS-232C/CCITT V.24 interface for attachment to an external modem. The IBM modems with which this line set can operate include those mentioned under Line Set 1A, as well as the following:

   IBM 3872 (2400/1200 bps)
   IBM 3874 (4800 bps)
   IBM 3875 (7200/3600 bps)
   IBM 3978-12 (2400 bps) (not available in the United States and Canada)
   IBM 3978-14 (4800 bps) (not available in the United States and Canada)
   IBM 4872 (4800 bps)

5. Line Set 1E (Autocall Adapter)—This line set has two interfaces for attachment of two external automatic calling units. These automatic calling units may be associated with any switched-network communication lines attached through Line Sets 1A, 1D, or 1G.

6. Line Set 1F (Medium Speed Local Attachment)—This line set provides for the local attachment of two IBM synchronous terminals at speeds up to 2400 bps via IBM-provided cables. Modems are not required. Total cable length may not exceed 100 feet. The attached terminal must provide its own clocking.
7. Line Set 1G (High Speed External Modem)—This line set provides for the attachment of one synchronous communication line for operation at speeds up to 50,000 bps. It has a digital interface for attachment to a switched or leased wideband external modem. The IBM modems with which this line set can operate include the following:

   IBM 3978-1 (20.4/40.8K bps) (not available in the United States and Canada)

   This line set can be attached only to a LIB Type 1 in a 3705 and only to a LIB Type A1 in a 3704.
8. Line Set 1H (Medium Speed Duplex External Modem)—This line set provides for the attachment of one duplex leased communication line at speeds up to 9600 bps; the line set has an EIA RS-232C/CCITT V.24 interface for attachment to an external modem. The IBM modems with which this line set can operate include those mentioned under line set 1D.
9. Line Set 1J (External Mil Std 188C Modem)—This line set provides for the attachment of one start-stop or synchronous communication line at speeds up to 50,000 bps via an external modem having an interface that conforms to the requirements of Mil Std 188C (Section 7.2.1). This line set, available only in the United States and Canada, can be attached only to a LIB Type 1 in a 3705 and only to a LIB Type A1 in a 3704.
10. Line Set 1K (External CCITT V.35 Modem)—This line set provides for the attachment of one point-to-point synchronous communication line at a speed of 40,800 or 48,000 bps via an external modem having an interface that conforms to the requirements of CCITT V.35. This line set, not available in the United States and Canada, can be attached only to a LIB Type 1 in a 3705 and only to a LIB Type A1 in a 3704.

Modem Attachment Base (2400 bps)—This attachment base provides for the attachment of up to two line sets 1L and 1M in any combination. The attachment base and line sets are available only for the 3704 with a LIB Type 1 or A1. Line sets 1L and 1M are equivalent to line sets 5A and 5B on the IBM 3705.

Note: This attachment base cannot be installed in conjunction with the remote program loader, the modem attachment base with auto-answer, the duplex data attachment base, or line set 1Q.

11. Line Set 1L (IBM 2400 bps Leased Point-to-Point Integrated Modem)—This line set provides for the attachment of one synchronous communication line at a speed of 1200 or 2400 bps. The line set includes an IBM 2400 bps integrated modem with receive equalization, suitable for communication with similarly equipped IBM modems over leased 3002 channels with C1, or equivalent, conditioning. No external modem is required.
12. Line Set 1M (IBM 2400 bps Multipoint Control Leased Line Integrated Modem)—This line set provides for the attachment of one synchronous line at a speed of 1200 or 2400 bps. The line set includes an IBM 2400 bps integrated modem with no equalization, suitable for communication with similar IBM multipoint tributary modems equipped with both transmit and receive equalization over leased 3002 communication channels with C1, or equivalent, conditioning. No external modem is required.

Modem Attachment Base with Auto-Answer (2400 bps)—This attachment base provides for the attachment of up to two line sets 1P. The attachment base and

line set are available only for the 3704 with a LIB Type 1 or A1 and only in the United States and Canada. Line set 1P is equivalent to line set 6A on the IBM 3705.

Note: This attachment base cannot be installed in conjunction with the modem attachment base, the duplex data attachment base, or line set 1Q.

13. Line Set 1P (IBM 2400 bps Switched Network Integrated Modem)—This line set provides for the attachment of one synchronous communication line at a speed of 1200 or 2400 bps. The line set includes an IBM 2400/1200 bps integrated modem equipped with auto-answer, suitable for communication over the switched telecommunications network with a similarly equipped modem. No external modem or autocall unit is required.
14. Line Set 1Q (IBM 2400 bps Switched Network Integrated Modem with Auto-Answer and Automatic Call Originate)—This line set provides for the attachment of one synchronous communication line at a speed of 1200 or 2400 bps. The line set includes an IBM 2400 bps integrated modem equipped with the auto-answer and automatic call originate (ACO) features. It is suitable for the automatic dialing of a remote station, the automatic answering of an incoming call, and communications over the switched communication network with a similar IBM modem, which must be equipped with the auto-answer feature. No external modem or autocall unit is required.

    Line set 1Q is available only for the 3704 with a LIB Type 1 or A1 and only in the United States and Canada. Line set 1Q is equivalent to LIB Type 7 on the IBM 3705.

    Only one line set 1Q can be installed per 3704.

    Note: Line set 1Q cannot be installed in conjunction with the modem attachment base, the modem attachment base with auto-answer, or the duplex data attachment base.

15. Line Set 1S (High Speed Half-duplex, CCITT V.35 Interface) - This line set provides for the attachment of one CCITT V.35 type interface to be used on a switched or non-switched communication facility at up to 56,000 bps. This line set is available only in the United States and Canada. It may only be attached to a LIB Type 1 in a 3705-I or 3705-II; no more than eight may be attached to the LIB.
16. Line Set 1T (High Speed Duplex External Modem) -This line set provides for the attachment of one duplex synchronous line that has a digital interface for attachment to an external modem for up to 50,000 bps switched or nonswitched wideband facilities. The control program must condition this line interface for external clock control. This line set can only be attached to a LIB Type 1 in a 3705-I or 3705-II; no more than four may be attached to the LIB.
17. Line Set 1U (High Speed Duplex, CCITT V.35 Interface) -This line set provides for the attachment of one duplex line that has a CCITT V.35 interface for attachment to an external modem for up to 56,000 bps switched or nonswitched communications facilities. The control program must condition this line interface for external clock control. This line set can only be attached to a LIB Type 1 in a 3705-I or 3705-II; no more than four may be attached to the LIB.

Duplex Data Attachment Base—This attachment base provides for the attachment of up to two line sets 1X and 1Y in any combination. The attachment base and line sets are available only for the 3704 with a LIB Type 1 or A1. Line sets 1X and 1Y are equivalent to line sets 11A and 11B on the IBM 3705.

Note: The duplex data attachment base cannot be installed in conjunction with the remote program loader, the modem attachment base, the modem attachment base with auto-answer, or line set 1Q.

18. Line Set 1X (IBM 2400 bps Point-to-Point Leased Line Duplex Data Integrated Modem)—This line set provides for the attachment of one synchronous duplex leased communication line at 1200 or 2400 bps. This line set includes one IBM 2400 bps integrated duplex data modem with receive equalization, suitable for communication over leased 3002 channels with C1, or equivalent, conditioning. No external modem is required.
19. Line Set 1Y (IBM 2400 bps Multipoint Control Duplex Data Integrated Modem)—This line set provides for the attachment of one synchronous duplex leased communication line at 1200 or 2400 bps. This line set includes one IBM 2400 bps integrated duplex data modem with no equalization, suitable for communication over leased 3002 channels with C1, or equivalent, conditioning. No external modem is required.

LIB Type A1: The LIB Type A1, available only for the 3704 with a type 2 communication scanner, provides for the attachment of all type 1 line sets. The attachment bases required for attachment of line sets 1L, 1M, 1P, 1X, and 1Y are also available for LIB Type A1.

LIB Type 2: The LIB Type 2 provides for the attachment of the following line set.

1. Line Set 2A (Telegraph Single Current)—This line set provides for the attachment of two single-current telegraph communication lines that can operate at line speeds up to 200 bps. Each line can be wired for 20 ma, 40 ma, or 62.5 ma single current termination.

LIB Type 3: The LIB Type 3 provides for the attachment of the following line sets.

1. Line Set 3A (Limited Distance Type 1 [2-wire] Line Adapter)—This line set provides for the attachment of two start-stop communication lines at speeds up to 134.5 bps. The line set includes two IBM Limited Distance Type 1 (2-wire) line adapters (for up to 4.75 wire miles). No external modems are required.
2. Line Set 3B (Limited Distance Type 1 [4-wire] Line Adapter)—This line set provides for attachment of two start-stop communication lines at speeds up to 134.5 bps. This line set includes two IBM Limited Distance Type 1 (4-wire) line adapters (for up to 4.75 wire miles). No external modems are required.

LIB Type 4: The LIB Type 4 provides for the attachment of the following line sets.

1. Line Set 4A (Limited Distance Type 2 [2-wire] Line Adapter)—This line set provides for the attachment of two start-stop communication lines at speeds up to 600 bps. The line set includes two IBM Limited Distance Type 2 (2-wire) line adapters (for up to 8.25 wire miles). No external modems are required.
2. Line Set 4B (Leased Line [2-wire] Line Adapter)—This line set provides for the attachment of two start-stop communication lines at speeds up to 600 bps. The line set includes two IBM Leased Line (2-wire) line adapters. No external modems are required.
3. Line Set 4C (Leased Line (4-wire) Line Adapter)—This line set provides for the attachment of two start-stop communication lines at speeds up to 600 bps. This line set includes two IBM Leased Line (4-wire) line adapters. No external modems are required.

LIB Type 5: The LIB Type 5, available for the 3705 only, provides for the attachment of the following line sets.

1. Line Set 5A (IBM 2400/1200 bps Point-to-Point Leased Line Integrated Modem)—This line set provides for the attachment of one synchronous communication line at a speed of 1200 or 2400 bps. The line set includes an IBM 2400/1200 bps integrated modem with receive equalization suitable for communication with a similarly equipped IBM modem over a leased 3002 channel with C1, or equivalent, conditioning. No external modem is required.
2. Line Set 5B (IBM 2400/1200 bps Multipoint Control Leased Line Integrated Modem)—This line set provides for the attachment of one synchronous communication line at a speed of 1200 or 2400 bps. The line set includes an IBM 2400/1200 bps integrated modem with no equalization, suitable for communication with a similar IBM multipoint tributary modem equipped with both transmit and receive equalization over a leased 3002 channel with C1, or equivalent, conditioning. No external modem is required.

LIB Type 6: The LIB Type 6, available for the 3705 only, provides for the attachment of the following line set. This LIB is available only in the United States and Canada.

1. Line Set 6A (IBM 2400/1200 bps Switched Network Integrated Modem)—This line set provides for the attachment of one synchronous communication line at a speed of 1200 or 2400 bps. The line set includes an IBM 2400/1200 bps integrated modem equipped with auto-answer and suitable for communication over the switched communication network with an IBM modem similarly equipped. No external modem or autocall unit is required.

LIB Type 7: (IBM 2400 bps Switched Network Integrated Modem with Automatic Call Originate). The LIB Type 7 provides the LIB and line set functions for the attachment, to the 3705 only, of one synchronous communication line at a speed of 1200 or 2400 bps. The line interface hardware includes an IBM 2400 bps modem equipped with the auto-answer and automatic call originate (ACO) functions. This modem is suitable for the automatic dialing of a remote station, the automatic answering of an incoming call, and communication over the switched communication network with a similar IBM modem, which must be equipped with the auto-answer feature. No external modem or autocall unit is required. LIB Type 7 is available only in the United States and Canada.

LIB Type 8: The LIB Type 8 provides for the attachment of the following line sets.

In the 3704 only, a modem attachment base (1200 bps) is required for the attachment of line sets 8A and 8B (up to two in any combination).

1. Line Set 8A (IBM 1200 bps Leased Integrated Modem)—For the 3705, this line set provides for the attachment of two synchronous communication lines at speeds up to 1200 bps in the United States. In countries outside the United States, it provides for the attachment of two start-stop lines at a speed of 600 bps or two synchronous lines at speeds of 600 bps or 1200 bps.

   For the 3704, line set 8A provides for the attachment of one synchronous non-switched line at speeds up to 1200 bps in the United States. In countries outside the United States, it provides for the attachment of one start-stop line at a speed of 600 bps or one synchronous line at a speed of 1200 bps.

This line set includes one (for the 3704) or two (for the 3705) IBM 1200 bps integrated modems suitable for communication over a leased, voice-grade channel with similar IBM modems. No external modems are required.

2. Line Set 8B (IBM 1200 bps Switched Network Integrated Modem)— For the 3705 this line set provides for the attachment of two synchronous communication lines at speeds up to 1200 bps. For the 3704, line set 8B provides for the attachment of one half-duplex synchronous line at speeds up to 1200 bps. The line set includes one (for the 3704) or two (for the 3705) IBM 1200 bps integrated modems equipped with auto-answer and suitable for communication over the switched communication network with similar IBM modems. No external modems are required. This line set is available only in the United States and Canada.
3. Line Set 8C (IBM 1200 bps Leased Line Integrated Modem with Break)—This line set, available only for the 3704, provides for the attachment of one half-duplex start-stop or synchronous leased communication line at speeds up to 1200 bps. The line set includes one IBM 1200 bps integrated modem with break, suitable for communication over a leased voice-grade channel with a similar IBM modem. The break capability is supported for start-stop operation up to 300 bps. No external modems are required.
4. Line Set 8D (IBM 1200 bps Switched Network Integrated Modem with Break)—This line set, available only for the 3704, provides for the attachment of one half-duplex start-stop or synchronous switched communication line at speeds up to 1200 bps. The line set includes one IBM 1200 bps integrated modem with break and auto-answer capability, suitable for communication over the switched communication network with similar IBM modems. The break capability is supported for start-stop operation up to 300 bps. No external modems are required.

LIB Type 9: For the 3705, the LIB Type 9 provides for the attachment of the following line set. For the 3704, LIB Type 9 includes the line set hardware. LIB Type 9 is available only in the United States and Canada.

1. Line Set 9A (IBM 1200 bps Switched Network Integrated Modem with Automatic Call Originate)—This line set provides for the attachment of one start-stop or synchronous communication line at speeds up to 1200 bps. The line set includes one IBM 1200 bps integrated modem equipped with the auto-answer and automatic call originate (ACO) functions. It is suitable for the automatic dialing of a remote station, the automatic answering of an incoming call, and communication over the switched communication network with a similar IBM modem (which must be equipped with the auto-answer feature and may be equipped with the ACO feature). No external modems or auto call units are required.

LIB Type 10: The LIB Type 10 provides for the attachment of the following line set.

1. Line Set 10A (IBM 1200 bps Leased Duplex Integrated Modem)—This line set provides for the attachment of one synchronous duplex leased communication line at speeds up to 1200 bps. The line set includes one IBM 1200 bps integrated modem. No external modem is required.

LIB Type 11: The LIB Type 11, available for the 3705 only, provides for the attachment of the following line sets.

1. Line Set 11A (IBM 2400 bps Point-to-Point Leased Line Duplex Data Integrated Modem)—This line set provides for the attachment of one synchronous

duplex leased communication line at a speed of 1200 or 2400 bps. The line set includes one IBM 2400 bps integrated duplex data modem with receive equalization, suitable for communication over leased 3002 channels with C1, or equivalent, conditioning. No external modem is required.

2. Line Set 11B (IBM 2400/1200 bps Multipoint Control Integrated Modem)—This line set provides for the attachment of one synchronous duplex leased communication line at 1200 or 2400 bps. The line set includes one 2400/1200 bps integrated duplex data modem with no equalization for multipoint master operation. It is suitable for communication over leased 3002 channels with C1, or equivalent, conditioning. No external modem is required.

LIB Type 12: The LIB Type 12, available only for the 3705, provides for the attachment of the following line sets.

1. Line Set 12A (IBM 1200 bps Leased Line Integrated Modem with Break)—This line set provides for the attachment of two half-duplex start-stop or synchronous leased communication lines at speeds up to 1200 bps. This line set includes two IBM 1200 bps integrated modems with break, suitable for communication over leased, voice-grade channels with similar IBM modems. The break capability is supported for start-stop operation up to 300 bps. No external modems are required.
2. Line Set 12B (IBM 1200 bps Switched Network Integrated Modem with Break)—This line set provides for the attachment of two half-duplex start-stop or synchronous switched communication lines at speeds up to 1200 bps. The line set includes two IBM 1200 bps integrated modems with break and auto-answer capability, suitable for communication over the switched communication network with a similar IBM modem. The break capability is supported for start-stop operation up to 300 bps. No external modems are required.

Clocking Requirements for Line Interface Bases and Line Sets

The following list indicates whether a communications controller line set (or line interface base, when no line sets are required) uses business machine (internal) clocking or modem (external) clocking. In general (but not always), business machine clocking is used for speeds of 2400 bps or less, and modem clocking is used for speeds greater than 2400 bps.

Line Set or LIB	*Type of Clocking*
1A	Business machine
1B	Business machine
1C	Business machine
1D	Business machine* or modem
1E	No clocking required for auto-call interface
1F	Business machine
1G	Modem
1H	Business machine* or modem
1J	Business machine* or modem
1K	Modem
1L	Modem
1M	Modem
1P	Modem
1Q	Modem
1S	Modem
1T	Modem
1U	Modem
1X	Modem
1Y	Modem
2A	Business machine
3A	Business machine
3B	Business machine
4A	Business machine
4B	Business machine
4C	Business machine
5A	Modem
5B	Modem
6A	Modem
7 (LIB)	Modem
8A	Business machine
8B	Business machine
8C	Business machine
8D	Business machine
9 (LIB)	Business machine
9A	Business machine
10A	Business machine
11A	Modem
11B	Modem
12A	Business machine
12B	Business machine

*Business machine clocking may be used for these line sets at speeds of 2400 bps or lower.

Appendix D: Publications Relating to the IBM 3704 and 3705

The chart below indicates the types of manuals that apply to each of six general functions that the 3704 or 3705 user may perform. The following pages contain synopses of the contents of all the publications currently available for the controllers. They are arranged in alphabetical order by category of manual (for example, program generation manuals, program logic manuals, and storage and performance manuals).

Learning	*Planning*	*Coding*	*Installing/ Generating*	*Operating*	*Maintaining*
Introduction	Preinstallation Guide and Installation Record Physical Planning Program Generation Storage and Performance	Assembler Language Principles of Operation User's Guide (UBHRs)* Handbook Program Logic Manual (NCP macros)**	Program Generation Storage and Performance User's Guide (fine tuning)	Operator Reference Card Control Panel Guide Program Generation (utilities)	Program Logic Manual** Handbook FETMM** Principles of Operation Control Panel Guide User's Guide (debug)*

*Network Control Program only.
**These manuals must be purchased.

Assembler Language

IBM 3704 and 3705 Communications Controller Assembler Language (GC30-3003)

The contents of this manual include:

- Basic assembler language concepts, such as coding conventions, terms, and expressions.
- A description of the communications controller machine instructions.
- A description of the function of the communications controller assembler instructions and how to code them.
- A description of the communications controller macro language and how to write a macro definition.

Control Panel Guides

Guide to Using the IBM 3704 Communications Controller Control Panel (GA27-3086)
Guide to Using the IBM 3705 Communications Controller Control Panel (GA27-3087)

The contents of these manuals include:

- A general description of the capabilities of the control panel.
- Step-by-step operating procedures that are program-independent.
- Step-by-step operating procedures for use with the emulation program.
- Step-by-step operating procedures for use with the network control program.
- A glossary of the panel controls that summarizes their functions and provides a cross-reference to the applicable procedures.
- A diagram of the control panel.
- A list of register addresses to be used in certain panel procedures.
- A description of the check and status lights on the panel.
- Emulation program and network control program control block layouts required to interpret certain panel displays.

FE Theory and Maintenance Manuals (FETMMs)

IBM 3704 Communications Controller Theory—Maintenance (SY27-0115)

The contents of this manual include:

- The control panel procedures and the control panel tests to direct the IBM Customer Engineer (CE) to a failing functional unit and to a failing field replaceable unit within the functional unit.
- The tests performed by the ROS bootstrap program and a description of the control panel procedures for use while diagnosing errors detected by the ROS bootstrap program.
- A description of the relationship between the central control unit and the adapters.
- A description of how the functional units of the 3704 work so that the CE can verify that the suspected card indicated by the diagnostics is actually causing the failure. The functional units described are:

  —Central control unit
  —Channel adapter
  —Communication scanners
  —Line interface bases and line sets
  —Power supply.

IBM 3705 Communications Controller Theory—Maintenance (SY27-0107)

Volume one contains:

- A maintenance philosophy section which points the IBM Customer Engineer (CE) to the correct part of the manual for locating a failure.
- The control panel procedures and the control panel tests to direct the CE to a failing unit.
- The tests performed by the ROS bootstrap program.
- A description of the central control unit and the storage to help a CE verify a problem.

Volume two contains a description of how the channel adapters and communication scanners work to help an IBM Customer Engineer verify problems.

Volume three contains a description of how the line interface bases, line sets, and power supply work to aid in detecting failures.

Handbook

IBM 3704 and 3705 Program Reference Handbook (GY30-3012)

The contents of this manual include:

- Diagrams showing various relationships between data areas for both the network control program (NCP) and the emulation program (EP).
- Layouts of all NCP and EP data areas with field and bit definitions.
- NCP commands and modifiers.
- Responses returned to the host by the NCP.
- EP command codes.
- 3704 and 3705 instruction set showing the mnemonic code and the bit pattern for each instruction.
- External register functions.
- Description and layout of the interface control word (ICW).
- NCP abend codes.
- Line character code charts.
- Examples of polling and addressing.
- Miscellaneous Data Recorder record formats.

Introduction

Introduction to the IBM 3704 and 3705 Communications Controllers (GA27-3051)

The contents of this manual include:

- A discussion of the advantages of the communications controllers, which introduces some general concepts.
- A general discussion of the 3704 and 3705 hardware units and their functions.
- A general discussion of the functions and use of the system support programs, including the program generation language and procedures, the assembler, and the loader and dump utility programs.
- A discussion of the concepts and functions of the network control program.
- A discussion of the concepts and functions of the emulation program.
- A discussion of the concepts and functions of the partitioned emulation programming extension to the network control program.
- Lists of the types of stations supported by the controllers in network control mode and emulation mode.
- A summary of the line interface bases and line sets available for the controllers.
- A summary of publications relating to the communications controllers.

Operator Reference Cards

IBM 3704 Operator Reference Summary (GA27-3091)

IBM 3705 Operator Reference Summary (GA27-3092)

These reference cards contain basic operating and error recovery procedures for the 3704 and 3705 operator. All procedures described are program-independent.

Physical Planning Manuals

IBM System/360 Installation Manual—Physical Planning (GC22-6820)

IBM System/370 Installation Manual—Physical Planning (GC22-7004)

IBM Remote Multiplexers and Communications Terminals Installation Manual—Physical Planning (GA27-3006)

These manuals contain physical specifications, electrical and environmental requirements, and cabling requirements for the IBM 3704 and 3705 Communications Controllers.

Preinstallation Guide/Installation Record

Teleprocessing Preinstallation Guide for IBM 3704 and 3705 Communications Controllers (GC30-3020)

This publication lists the equipment characteristics of the teleprocessing network and communications controller that the user must specify when coding an emulation program or network control program. The publication consists of a series of tables, one for each type of station supported by the program and one for each type of line set with which the controller can be equipped. Each table gives the appropriate values to code for the station or line set represented. For some characteristics several values are listed, the appropriate choice depending on how the user's station is equipped (for instance, which transmission code it employs) or in which of alternate modes he wishes the station or line to operate. In these cases, accompanying notes suggest where the user may learn the values appropriate for his installation.

Teleprocessing Installation Record for IBM 3704 and 3705 Communications Controllers (GC30-3021)

This publication provides the user with a convenient means for recording the details of his 3704- or 3705-based teleprocessing configuration—existing or planned—that he must know before coding an emulation program or network control program. As furnished, the publication consists of a series of formatted charts, each of which has appropriately labeled spaces representing the information items pertinent to a particular type of communication line (such as a multipoint communication line) and the stations associated with that line. A chart is also provided for recording the hardware units installed in the communications controller, along with related information such as line interface and subchannel addresses used.

From the package of charts provided, the user selects the number and types appropriate to his teleprocessing configuration. Upon filling in the information indicated and assembling the charts into a binder, he has a convenient record of his configuration that gives much of the information needed to code a program appropriate to his installation. (The charts also contain spaces for related infor-

mation not needed in coding the program, for example, common-carrier circuit numbers.)

Principles of Operation

IBM 3704 and 3705 Communications Controllers Principles of Operation (GC30-3004)

The contents of this manual include:

- A general description of the 3704 and 3705 communications controllers and their functional hardware units.
- A description of the registers, interrupt scheme, and program levels.
- A description of the basic storage addressing procedure and the format for addressing the individual communication lines.
- A description of the 3704 and 3705 machine instructions with their formats and condition codes.
- Descriptions of the operation and programming requirements of the central control unit, the communication scanners, and the channel adapters.
- External register functions.
- Input/Output instruction bit definitions.
- A summary of Input/Output instructions.

Program Generation Manuals

IBM 3704 and 3705 Communications Controllers Network Control Program Generation and Utilities Guide and Reference Manual (for OS/MFT and OS/MVT TCAM Users) (GC30-3001)

IBM 3704 and 3705 Communications Controllers Network Control Program/VS Generation and Utilities Guide and Reference Manual (for OS/VS TCAM Users) (GC30-3007)

These manuals cover respectively the network control program, version 1, and the network control program, version 2. Their contents include:

- The teleprocessing characteristics that the analyst or programmer must consider when defining the network control program.
- Detailed descriptions of the macro instructions that define a network control program and how to code them.
- How to create a network control program load module by executing the program generation procedure once the generation macros have been coded.
- How to use the independent loader and dump utility programs.
- Diagnostic messages produced by the program generation procedure and the utility programs.
- Coding examples for switched network dial sets and multiple terminal access operation.
- Sign-on procedures for operators of multiple terminal access stations.

IBM 3704 and 3705 Control Program/VS Generation and Utilities Guide and Reference Manual (GC30-3008)

This manual contains information on NCP 5 similar to that on NCP 1 and NCP 2 in the generation manuals described above.

IBM 3704 and 3705 Communications Controllers Emulation Program Generation and Utilities Guide and Reference Manual (GC30-3002)

The contents of this manual include:

- Detailed descriptions of the macro instructions that define an emulation program and how to code them.
- How to create an emulation program load module by executing the generation procedure once the generation macros have been coded.
- How to use the independent loader and dump utility programs.
- Coding example for emulation program generation.
- Storage requirements for the loader and dump programs and for emulation program generation.
- Diagnostic messages produced by the program generation procedure and the utility programs.

This manual covers both OS and DOS considerations where differences exist.

Program Logic Manuals (PLMs)

IBM 3704 and 3705 Communications Controllers Network Control Program, Program Logic Manual (SY30-3003)

IBM 3704 and 3705 Communications Controllers Network Control Program/VS, Program Logic Manual (SY30-3007)

These manuals cover respectively the network control program, version 1 and the network control program, version 2. Their contents include:

- A summary of command processing in the network control program (NCP), including data flow and control flow.
- The physical organization of the NCP.
- A description of the functional units of the NCP including:
  - —Initialization, initiation, and termination.
  - —Channel adapter management.
  - —Level 1 processing.
  - —Interval timer routines.
  - —Serviceability aids.
  - —Multiple terminal access facility.
  - —Block handler support.
  - —Tasks in the NCP.
  - —System supervisor.
- A verbal description of the major data areas in the NCP.
- Method of Operation diagrams describing in detail the following NCP functions and relating them to the NCP code:
  - —Initialization.
  - —Channel adapter management.
  - —Processing requests from the host.
  - —Processing machine and program checks.
  - —Serviceability aids.
  - —Block handling functions.
  - —Termination.
- A detailed description of the NCP system supervisor, relating its functions to the macros used to request those functions.

- A cross-reference table listing all NCP CSECTs with their entry points, functions, exits, and method of operation diagrams that refer to them.
- Formats of the NCP macro instructions.
- A generalized layout of the NCP modules in controller storage.
- The standard labels used to refer to external registers.
- A chart of register usage by CSECT.
- A cross-reference chart listing pertinent information about each of the Control commands.
- A summary of online terminal testing and a detailed description of each online test interpretive command.
- A chart showing the sequence in which level 5 subtasks are executed to process each type of request from the host.
- Charts showing the line operations performed by the NCP for each type of I/O command.
- Diagrams showing save area formats.
- Information about the status and sense indications presented to the host by the NCP via the channel adapter.

IBM 3704 and 3705 Communications Controllers Network Control Program/VS Program Logic Manual (SY30-3013).

This manual contains information on NCP 5 similar to that on NCP 1 and NCP 2 in the PLMs described above.

IBM 3704 and 3705 Communications Controllers Emulation Program, Program Logic Manual (SY30-3001)

The contents of this manual include:

- A description of the physical and logical organization of the emulation program (EP).
- A description of the EP data areas, including control areas, tables, and queues.
- A description of the functions of the EP, divided according to the functions of the interface control program (ICP) and the line control program (LCP).
- Method of Operation diagrams describing in detail the following EP functions and relating them to the EP code:
  - —Level 3 interrupt handling.
  - —Level 2 interrupt handling.
  - —Queue management.
  - —Level 1 error detection.
  - —Panel display request processing.
- A directory listing the EP routines with their function and other pertinent cross-reference information.
- A description of diagnostic aids, incuding:
  - —Error detection.
  - —Error recovery
  - —Error isolation tools.
  - —A summary of general register usage in the EP.
- Summaries of status and sense information presented to the host processor.
- A chart showing the relationship between EP generation macros and the routines they cause to be included in the EP.

Storage Estimate Manuals

Storage Estimates and Performance Planning for the IBM 3704 and 3705 Communications Controllers Network Control Program (GC30-3006)

The contents of this manual include:

- How to estimate storage requirements for a given configuration of the network control program, including:
  - —Basic code requirements.
  - —Storage requirements for optional system functions.
  - —Storage requirements for support of particular communication line and station types.
  - —Storage requirements for control blocks that vary according to configuration.
  - —Storage requirements for user-generated code.
  - —Storage requirements for buffers.
  - —Storage requirements for the PEP extension.
- How to select options that may improve the performance of the network control program, including:
  - —Channel adapter options.
  - —Internal NCP options, such as network slowdown threshold values, sub-blocking options, and block-handling routines.

Storage Estimates for the IBM 3704 and 3705 Communications Controllers Emulation Program (GC30-3005)

The contents of this manual include how to estimate storage requirements for a given configuration of the emulation program, including:

- —Storage requirements for support of various hardware options and terminals.
- —Storage requirements for support of various transmission codes.
- —Storage requirements for serviceability aids.
- —Storage requirements for control blocks and tables that vary according to configuration.

User's Guide

Network Control Program/TCAM Network User's Guide (GC30-3009)

The contents of this manual include:

- A description of how TCAM and the network control program (NCP) communicate, including the use of the BTU and a summary of channel operations.
- A description of how the NCP operates the communications controller.
- A description of how the NCP and TCAM work together to control the communication network.
- A summary of aids for diagnosing the NCP/TCAM network.
- A sample UBHR program.
- A summary of the NCP and TCAM generation macro instructions.
- A summary of TCAM commands for the NCP.
- An example of an NCP storage dump.

List of Abbreviations

ACO	Automatic Call Originate
AT&T	American Telephone and Telegraph Company
BCD	Binary Coded Decimal
BH macro	block handling macro
BH set	block handler set
BHR	block handling routine
bksp	backspace
bps	bits per second
BSC	binary synchronous communications
CA	channel adapter
CCITT	Comite Consultatif International Telegraphique et Telephonique (Consultative Committee on International Telegraphy and Telephony)
CPU	central processing unit
DOS	Disk Operating System
DOS/VS	Disk Operating System/Virtual Storage
EBCD	Extended Binary Coded Decimal
EBCDIC	Extended Binary Coded Decimal Interchange Code
EIA	Electronic Industries Association
EP	Emulation Program
ERP	error recovery procedure
FDX	(Full) Duplex
ID	identification
I/O	input/output
IPL	initial program load
K	thousand (1,024, when referring to bytes of storage)
LIB	line interface base
LU	Logical Unit
ma	milliampere
MTA	Multiple Terminal Access
NCP	Network Control Program
OLLT	online line test
OLTT	online terminal test
OS	Operating System
OS/VS	Operating System/Virtual Storage
PEP	Partitioned Emulation Programming
PU	Physical Unit
RPQ	Request for Price Quotation
SDLC	synchronous data link control
SNA	Systems Network Architecture
SSCP	System Services Control Point
TCAM	Telecommunications Access Method
TCU	Transmission Control Unit
TP	teleprocessing
TWX	Teletypewriter Exchange
USASCII	United States of America Standard Code for Information Interchange
VS	Virtual Storage
VTAM	Virtual Telecommunications Access Method
WU	Western Union

Glossary

IBM is grateful to the American National Standards Institute (ANSI) for permission to reprint its definitions from the American National Standard Vocabulary for Information Processing (Copyright 1970 by American National Standards Institute, Incorporated), which was prepared by Subcommittee X3.5 on Terminology and Glossary of the American National Standards Committee X3.

Access method. A data management technique for transferring data between main storage and input/output units.

Addressing. The means whereby the originator or control unit selects the teleprocessing unit to which it is going to send a message.

Alternate local/remote communication link. A switched, point-to-point communication line used as an alternate path between a local controller and a remote controller when the regular local/remote communication link has failed.

Attachment base. A 3705 hardware feature that provides the controls to the central control unit for the 3705 adapters.

Bit service. The process of character assembly or disassembly.

Block handler (BH). A group of block handling routines that are executed sequentially to process a block of data at a specified point in its path through the network control program.

Block handler (BH) set. A group of block handlers. A BH set may be associated with one or more teleprocessing units.

Block handling macro (BH macro). One of the control program generation macros that describe optional block processing functions to be included in the network control program.

Block handling routine (BHR). A routine that performs a single processing function for a block of data passing through the network control program. A typical BHR function is inserting the date and time of day in the block.

Buffer. An area of storage that is temporarily reserved for use in an input/output operation, into which data is read or from which data is written.

Central control unit. The controller hardware unit that contains the circuits and data flow paths needed to execute the instruction set and to control controller storage and the attached adapters.

Channel adapter (CA). A controller hardware unit that provides attachment of the controller to a System/360 or System/370 channel.

Channel-attached controller. Equivalent to *local controller.*

Character assembly. The process by which bits are put together to form characters as the bits arrive on a communication line. In the controllers, character assembly is performed either by the control program or by the communication scanner, depending on the type of scanner installed.

Character code. A system of representing digits, letters, special symbols, or control functions by assigning a particular bit pattern to each character. All characters represented in the same character code have the same number of bits.

Character disassembly. The process by which characters are broken down into bits for transmission over a communication line. In the controllers, character disassembly is performed either by the control program or by the communication scanner, depending on the type of scanner installed.

Character service. The process by which a character is moved to a buffer from the storage area where it was assembled.

Checkpoint/restart. A facility that records the status of the teleprocessing network at designated intervals or following certain events. Following system failure, the system can be restarted and continue without loss of messages.

Cluster. A station that consists of a control unit and the terminals attached to it.

Communication line. The means of connecting one location to another for the purpose of transmitting and receiving data. In this publication, the term refers to any communication facility of the communications common carrier, whether it is actually a wire or some other means of communication, such as radio or satellite.

Communication scanner. A controller hardware unit that provides the connection between line interface bases and the central control unit. The communication scanner monitors the communication lines for service requests.

Component. An independently addressable part of a station that performs either an input or an output function but not both.

Configuration macro. One of the control program generation macros that provide information necessary to construct the tables needed by the control program to control the flow of data between the controller and stations and between the controller and the host processor.

Control program generation language. The set of macro instructions and associated operands by which the user defines for the controller the network configuration and operating parameters of the teleprocessing subsystem.

Control program generation procedure. A two-stage process that creates a control-program load module based on parameters specified by the user through the control program generation language.

Cycle steal. The process by which a type 2 or a type 3 channel adapter acquires machine cycles from the 3705 control program for data transfer.

***Duplex.** In communications, pertaining to a simultaneous two-way independent transmission in both directions. Contrast with *half duplex.* Synonymous with *full duplex.*

Duplex communication line. A communication line having two independent data paths over which data can be transmitted in both directions simultaneously. (Also called *full-duplex communication line.*) Contrast with *half-duplex communication line.*

Dynamic. Occurring at the time a program is executed.

Dynamic buffering. Allocating storage as it is needed for incoming data during program execution.

Dynamic control function. One of the network control program functions initiated by a Control command from the host access method.

Element. A part of the teleprocessing network defined by a control program generation macro. Possible elements are line groups, communication lines, clusters, terminals, and components.

Emulation Program (EP). A control program that allows a local 3704 or 3705 to operate functionally as an IBM 2701 Data Adapter Unit, an IBM 2702 Transmission Control, an IBM 2703 Transmission Control, or any combination of the three.

Error recovery procedure (ERP). A program that automatically attempts to correct a transmission error.

Formatted dump. A dump in which certain network control program control blocks are isolated and identified.

Full-duplex communication line. Equivalent to *duplex communication line.*

Generation delimiter macro. The macro that marks the end of the control program generation input stream.

***Half-duplex.** In communications, pertaining to an alternate, one way at a time, independent transmission. Contrast with *duplex.*

Half-duplex communication line. A communication line having a single data path over which data can be transmitted in either direction, but not simultaneously. Contrast with *duplex communication line.*

Hard stop. Immediate termination of controller operation without the execution of orderly closedown procedures.

Hardware check. A failure in a hardware unit that halts operation.

Host processor. The central processing unit to which the controller is attached by a channel and that executes the teleprocessing access method that supports the controller.

Initial test routine. A diagnostic program executed in the controller before the control program is loaded. The initial test routine tests the controller hardware for conditions that might cause failure after operation begins.

Interrupt. A break in the normal sequence of instruction execution. It causes an automatic transfer to a preset storage location where appropriate action is taken.

Invite. A network control program teleprocessing command that starts a session with a teleprocessing device by allowing the device to send data to the host processor.

Line. Equivalent to *communication line.*

Line adapter. An IBM modem that is a feature of a particular product. Some communications controller line sets include line adapters; others require external modems. See also *modem.*

Line control character. A special character that controls transmission of data over a communication line. For example, line control characters are used to start or end a transmission, to cause transmission-error checking to be performed, and to indicate whether a station has data to send or is ready to receive data.

Line group. A group of communication lines by which stations supported by the same line-control discipline are connected to the controller.

Line interface base (LIB). A controller hardware unit that provides for the attachment of communication lines to the controller.

Line scanner. See *communication scanner.*

Line set. A controller hardware unit through which one or two lines are attached to a line interface base.

Load module. A program in a format suitable for loading into storage for execution.

Local controller. A channel-attached communications controller, which may be connected by a communication line to one or more distant controllers called remote controllers. All transmissions over the local/remote communication link are initiated and controlled by the local controller.

Local network control program. A network control program, version 5, executed in a local controller and able to communicate with a network control program in a remote controller.

Local/remote communication link. A duplex or half-duplex communication line linking a local controller and a remote controller, over which message data flows between the access method (via the local controller) and the remote controller. A local/remote communication link is also used for loading a network control program, version 5, into a remote controller and for transferring to the host processor the contents of remote controller storage (dumping). All transmission over the local/remote communication link is controlled by the local network control program. See also *alternate local/remote communication link.*

***Modem.** (MOdulator-DEModulator) A device that modulates and demodulates signals transmitted over communication facilities. See also *line adapter.*

*American National Standard Definition

Multiprocessor. A computer employing two or more processing units under integrated control. A tightly-coupled multiprocessor is a computer employing two or more processing units that are controlled by the same operating system and share all of main storage and most of auxiliary storage.

NCP. See *Network Control Program.*

Network Control Program (NCP). A control program for the controllers, generated by the user from a library of IBM-supplied modules.

Parameter. A variable that is given a constant value for a specific purpose or process.

Partitioned Emulation Programming (PEP). A feature of the network control program (except version 1) that allows a local 3704 or 3705 to operate as an IBM 2701, 2702, 2703 control unit (or any combination of the three) for certain communication lines, while performing network control functions for other lines in the teleprocessing network.

Pause-retry. A network control program option that allows the user to specify how many times the program should try to retransmit data after a transmission error occurs, and how long the program should wait between successive attempt.

Polling. A technique by which each of the teleprocessing units sharing a communication line is periodically interrogated to determine whether it has data to send.

Primary controller. Equivalent to *local controller.*

Primary network control program. Equivalent to *local network control program.*

Program check. An error in a program that suspends execution of the program.

Program product. A licensed program that performs a function for the user and usually interacts with and relies upon system control programming or some other IBM-provided control program.

***Record.** A collection of related items of data treated as a unit.

Remote controller. A 3704 or 3705 that communicates with a local controller over a local/remote communication link.

Remote network control program. A network control program, version 5, that is executed in a remote controller.

Remote Program Loader. A feature that includes a read-only storage unit and a small auxiliary storage device installed in a remote controller to allow the controller to be loaded and dumped over the local/remote communication link.

Resource. Any facility of a computing system or operating system required by a job or task, including main storage, input/output units, processing time, etc.

Secondary controller. Equivalent to *remote controller.*

Secondary network control program. Equivalent to *remote network control program.*

*American National Standard Definition

Station. A point in a teleprocessing network at which data can either enter or leave.

Subchannel. The CPU channel facility required for sustaining a single I/O operation.

Switched Network Backup. An optional facility of the network control program that allows the user to specify for certain types of stations a switched line to be used as an alternate path if the primary line becomes unavailable due to an irrecoverable error.

Symmetrical I/O unit. A unit that is attached to two processors, appears as the same I/O unit to each processor, and can be accessed in the same manner by each processor.

Synchronous Data Link Control (SDLC). A discipline for the management of synchronous, transparent, serial-by-bit information transfer over a communication channel. Transmission exchanges may be duplex or half-duplex over switched or dedicated communication lines. The communication channel configuration may be point-to-point, multipoint, or loop. SDLC includes comprehensive detection and recovery procedures for transmission errors introduced by the communication channel.

System macro. One of the control program generation macros that provide information pertaining to the entire controller.

Teleprocessing. The processing of data that is received from or sent to remote locations by way of telecommunication channels.

Teleprocessing unit. A unit of teleprocessing equipment linked to the controller via a communication line and identified as a cluster, terminal, or component at the time the control program is generated.

Teleprocessing network. The stations that are controlled by a single access method (or, in the controllers, by a single control program), and the communication lines by which they are linked to the transmission control unit.

Teleprocessing subsystem. The part of a data processing system devoted to the transfer of data across communication lines. The subsystem consists of the stations, modems (data sets), communication lines, and the transmission control unit.

Terminal. A teleprocessing unit capable of sending and receiving information over a communication line.

Tightly-coupled multiprocessor. See *multiprocessor.*

Transmission code. A character code for sending information over communication lines.

Transmission Control Unit (TCU). An input/output control unit that addresses messages to and receives messages from a number of remote stations.

Trunk line. Equivalent to *local/remote communication link.*

Two-channel switch. A hardware feature that allows the controller to be attached to two CPU channels through a single type 1 or type 2 channel adapter.

Uniprocessor. A computer employing one processing unit.

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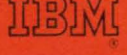

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