

Systems

**Introduction to the IBM 3705
Communications Controller**

IBM

Preface

The IBM 3705 Communications Controller is a transmission control unit that is controlled by a program resident in it. The 3705 has all the capabilities of previous IBM transmission control units and also assumes line-control and processing responsibilities formerly allocated to a teleprocessing access method.

This publication contains introductory information on both the hardware and the program components of the 3705. Any user or potential user of the 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 five sections:

- **General 3705 Concepts**—This chapter gives an overview of the place of the 3705 in the teleprocessing environment. It discusses primarily the advantages of the 3705 to the teleprocessing installation.
- **3705 Hardware Concepts**—This chapter discusses the functions of the 3705 hardware components and features. It also indicates which features can be combined and the type of support each feature provides.
- **The System Support Programs**—This chapter covers the NCP generation procedure, the 3705 assembler, and the utilities. Primary emphasis is on the structure and use of the Network Control Program generation language.
- **Network Control Program Concepts**—This chapter summarizes the services (both standard and optional) provided by the Network Control Program and introduces several unique NCP design features.
- **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.

The appendixes contain information on (1) the devices supported by the 3705 with the Network Control Program, (2) the capabilities of the 3705 line-attachment hardware, (3) the interfaces between 3705 line sets and external data sets or autocall units, and (4) the devices supported by the 3705 with the Emulation Program.

A *teleprocessing subsystem*, as referred to in this publication, includes remote stations, data sets (or modems), communication lines, and the transmission control unit (TCU). The *teleprocessing network* consists of one or more stations and the communication lines that connect them to the TCU. The term *station* refers to the teleprocessing equipment at the remote end of a communication line. A station may include one or several teleprocessing devices. A *teleprocessing device* is a single piece of equipment that communicates with a computer from a remote location over a communication line. A device can be a terminal, a terminal component, a control unit, or another computer.

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Changes are periodically made to the information herein; any such changes will be reported in subsequent revisions or Technical Newsletters.

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List of Abbreviations

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
bkspace	backspace
bps	bits per second
BSC	binary synchronous communications
CA	channel adapter
CCITT	Comité Consultatif International Télégraphique et Téléphonique (Consultative Committee on International Telegraphy and Telephony)
CPU	central processing unit
DOS	Disk Operating System
EBCD	Extended Binary Coded Decimal
EBCDIC	Extended Binary Coded Decimal Interchange Code
EIA	Electronic Industries Association
EOB	end of block
EOT	end of transmission
EP	Emulation Program
ERP	error recovery procedure
ETB	end of transmission block
ETX	end of text
ID	identification
I/O	input/output
IPL	initial program load
K	thousand (1,024, when referring to bytes of storage)
LIB	line interface base
ma	milliampere
NCP	Network Control Program
OLTT	on-line terminal test
OS	Operating System
RPQ	Request for Price Quotation
SOH	start of heading
STX	start of text
TCAM	Telecommunications Access Method
TCU	Transmission Control Unit
TP	teleprocessing
TWX	Teletypewriter Exchange
USASCII	United States of America Standard Code for Information Interchange
WU	Western Union



IBM 3705 Communications Controller—A B-Model

Chapter 1: General 3705 Concepts

Teleprocessing is a growing part of the data processing industry. Teleprocessing operations must be flexible to accommodate the increasing diversity of teleprocessing devices, 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 3705 Communications Controller is a transmission control unit designed to assume many of the line-control and processing functions for the teleprocessing subsystem. In the past, primary control of the teleprocessing network was 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 was a function of the transmission control unit, operating in response to commands from the access method. The 3705 performs all the usual functions of a transmission control unit and, in addition, takes over many of the capabilities of an access method. In this way, the 3705 removes much of the control of the teleprocessing subsystem from the CPU. Figure 1 illustrates this concentration of control in the 3705.

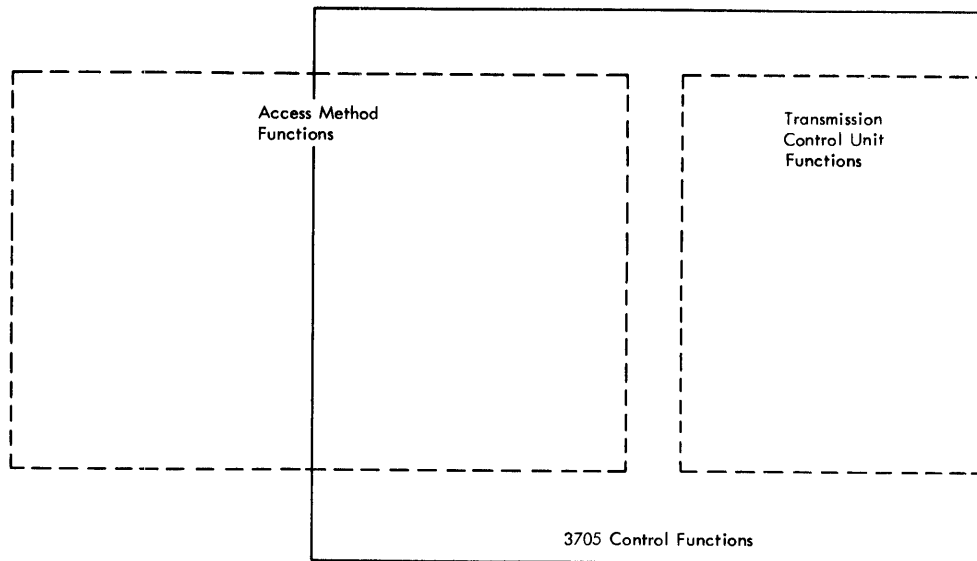


Figure 1. Centralization of Function in the IBM 3705

The 3705 is designed for local attachment to an IBM System/360 using a byte-multiplexer channel or to an IBM System/370, using a selector, byte-multiplexer, or block-multiplexer channel. The central processing unit that supports the 3705 is called the *host processor*.

Much of the increased capability of the 3705 is provided by the Network Control Program (NCP), a control program that is executed in the 3705. The NCP provides the flexibility necessary to meet increasing teleprocessing demands and at the same time relieves the CPU of much of the teleprocessing responsibility.

The NCP requires the support of an access method in the host processor. IBM supplies this support in the OS Telecommunications Access Method (TCAM) for System/370. The specific features offered by TCAM for NCP support are described in the publication, *Planning for TCAM with the IBM 3705 Communications Controller*, GC30-2028-0.

IBM also provides an Emulation Program (EP) to run in the 3705. 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 3705 without modification. The EP is supported under System/360 and System/370.

IBM also supplies a group of programs to support the Network Control Program and the Emulation Program. These include facilities to generate the control program (NCP or EP), assemble programs written in 3705 assembler language, load programs into the 3705, and dump 3705 storage. The support programs for both the NCP and the EP are supported by the Operating System (OS) in an IBM System/360 or System/370 CPU. In addition, programs that provide the same functional support are available for the EP to run under the Disk Operating System (DOS) for System/360.

Advantages of the IBM 3705

The IBM 3705 Communications Controller has most of the functional capabilities and features of the current line of IBM transmission control units (TCUs)—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 3705 offers many advantages over these TCUs.

The 3705 can be compared to any of the transmission control units mentioned above. In the following discussion, however, only the largest of them, the IBM 2703, is used for comparison. Figure 2 summarizes some of the advantages of the 3705 with the Network Control Program.

The 3705 Is Flexible

Flexibility is one of the greatest advantages of the 3705. Both the hardware and the Network Control Program (NCP) are designed to allow a high degree of flexibility in configuring the 3705 to meet the particular requirements of most teleprocessing installations.

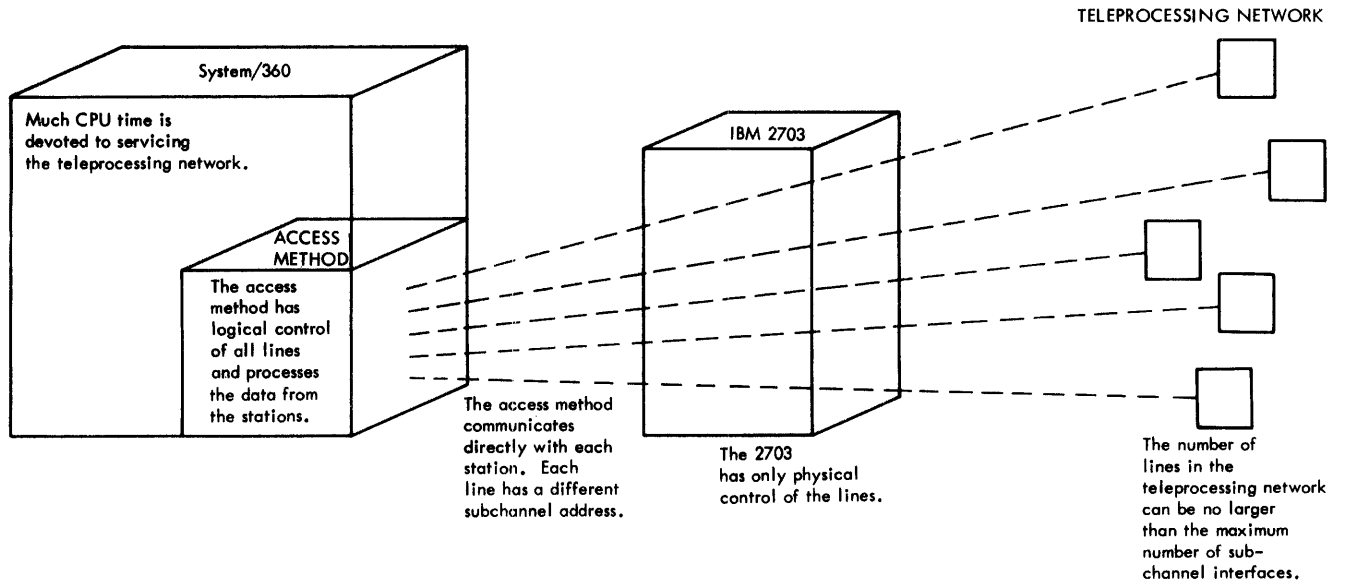
The 3705 can communicate with a variety of teleprocessing devices using both synchronous and asynchronous line-control disciplines at line speeds from 45.5 bps to 50,000 bps. For a list of the devices supported, see *Appendix A: Devices Supported by the IBM 3705 Communications Controller with the Network Control Program*. The NCP recognizes and translates a wide range of transmission codes, including USASCII, EBCDIC, EBCD, BCD, and Correspondence Code.

The line-attachment hardware available for the 3705 allows up to 352 lines to be attached, twice as many as can be attached to the 2703. The actual number of lines that the 3705 can support depends upon performance factors and the combination of features chosen for the 3705.

The 3705 hardware offers flexibility in the choice of channel adapters and line scanners. Depending upon the anticipated volume of throughput through the 3705, you can choose between two types of channel adapters and line scanners. One type offers high throughput and performance capabilities; the other type can handle less throughput, but is more economical for installations with smaller networks.

In addition, the 3705 line-attachment hardware allows many different line types 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 IBM 2703. This characteristic of the 3705 allows considerable flexibility in the number of line types that can be attached. This is especially advantageous when an installation requires a few lines of several different types. In many cases, such a network requires only one scanner with a minimum • of attachment hardware.

A TELEPROCESSING SUBSYSTEM WITH AN IBM 2703



A TELEPROCESSING SUBSYSTEM WITH AN IBM 3705

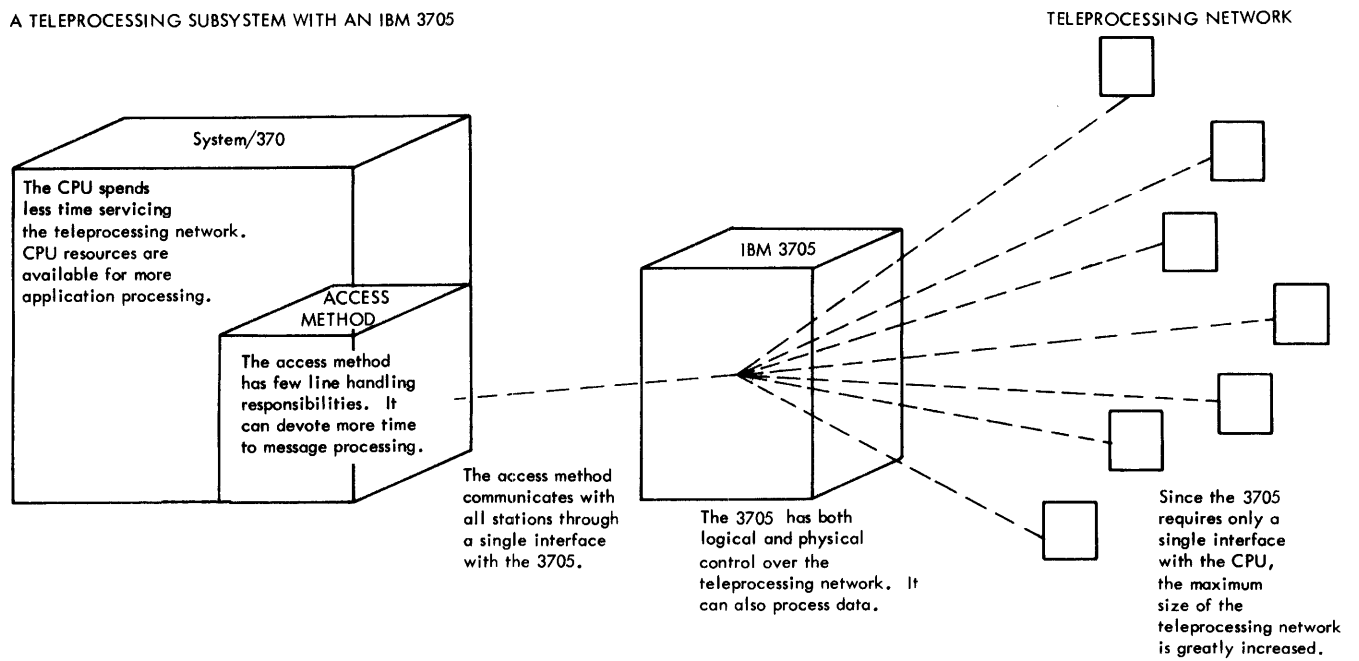


Figure 2. Advantages of the IBM 3705 over the IBM 2703

The Network Control Program (NCP) enhances the flexibility of the 3705 hardware. The standard NCP functions include a wide range of facilities to control the teleprocessing subsystem. In addition, the NCP includes a number of optional functions that can be performed either in the 3705 or by the access method, or, in some cases, omitted entirely.

You describe the NCP that meets the requirements of your installation by using a high-level macro language, the NCP generation language. This language gives you control over many of the characteristics of the NCP. You control some characteristics by specifying particular values for certain NCP 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 do not have to specify the order in which 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 3705 scanning mechanism is program-controlled, the scanning hardware need not be rewired for every change in network configuration. When new lines are added to the network, any modifications to the scanning scheme are made automatically when the NCP is regenerated to include the new lines.

This characteristic also permits the generation of several different NCPs to handle different subsets of lines, all attached to the same 3705. Whichever NCP is currently resident in the 3705 controls which lines are scanned and in which order, depending upon the parameters specified when that NCP was generated.

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

The 3705 Is Modular in Design

Much of the flexibility of the 3705 comes from the modular design of the 3705 hardware and the Network Control Program. Such modularity allows the 3705 to grow easily to meet the needs of a growing teleprocessing subsystem.

The 3705 hardware is available in twenty models that allow you to get as little or as much hardware as necessary to support your network. The various models offer options in the amount of storage, the number of scanners and channel adapters, and the amount of line-attachment hardware you can order.

Also, the NCP is designed in modules that are selected according to the requirements of the network. Since every teleprocessing subsystem does not require all the facilities of the NCP, you can specify through the NCP generation language only those facilities that your particular installation needs. The NCP generation procedure automatically selects the appropriate modules to perform those functions.

The 3705 Offers High Availability

Many characteristics of the 3705 hardware and the Network Control Program (NCP) work together to ensure that availability of the 3705 to perform its normal teleprocessing functions is high.

The NCP, for example, provides error recovery procedures (ERPs) that can correct many intermittent hardware errors, such as data-transmission line errors. In most cases, the 3705 remains available to the rest of the network while the ERPs are being executed.

Some hardware options also increase the availability of the 3705. For example, the 3705 channel adapters have a two-channel switch feature that allows each of them to be

attached to two channels at once. If one channel fails, the channel adapter can be manually switched to the second channel.

Another option that increases availability is the ability of most models of the 3705, when running with the NCP, to support two channel adapters of the high-performance type. This feature allows physical attachment of the 3705 to two different CPUs, so that if one CPU fails, the 3705 can be switched to the second upon receipt of a command from the host access method. If both channels have the two-channel switch, the 3705 can be attached to as many as four CPUs, making availability even higher.

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

The 3705 Conserves CPU Resources

The 3705 takes over many functions that were previously performed by the teleprocessing access method. In doing so, it frees 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 3705. Much of the line-control information previously maintained by the access method in control blocks is now maintained by the Network Control Program (NCP). In addition, the 3705 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 device, 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. With a large network, host storage requirements for buffers and control blocks may be reduced by as much as 75,000 bytes.

The NCP 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 NCP saves the host processor both the time and the main storage required by the processing programs.

The 3705 Uses A Single Subchannel Address

An advantage to the entire data processing installation is that the 3705, when running with the Network Control Program (NCP), occupies a single control-unit position on the channel and requires only a single subchannel address to communicate with the host processor. (The IBM 2703 requires a separate subchannel address on a byte-multiplexer channel for each line in the network.) Therefore, if the 3705 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 the 3705 with the NCP needs only one subchannel address, it can be attached to a System/370 selector channel, regardless of the number of lines in the network. This capability is advantageous to a teleprocessing subsystem with high-speed lines and high throughput requirements.

The Design of the 3705 Increases Reliability and Reduces Overhead

The 3705 is designed so that data is transferred between remote stations and the host processor with maximum reliability and efficiency. The 3705 has four interrupt levels, performing those functions that are most critical at the highest priority level. Correspond-

ingly, the Network Control Program (NCP) 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 3705 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 lines and the handling of data as it arrives and leaves. The 3705 hardware and the control program interact very closely at this level to prevent loss of data arriving on a line.

The 3705 has 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 3705 can devote more time to the network-control functions.

Additional overhead is eliminated if the high-performance channel adapter is installed in the 3705. This type of adapter uses *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 3705 Provides Many Error Recovery and Diagnostic Facilities

The Network Control Program (NCP) has a number of error recovery procedures and diagnostic facilities to enhance the reliability and serviceability of the 3705.

Some error recovery procedures (ERPs) are executed automatically by the NCP when a line error occurs. If these procedures fail to correct the error, the NCP can perform other ERPs, or it can notify the access method of the error and allow the access method to try to solve the problem.

The NCP 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 NCP. If this facility is included, the NCP sends the host processor records containing the status of each line in the network whenever requested by the access method. These records can then be used when the 3705 is restarted to restore the network to its status immediately before closedown.

Other diagnostic aids are also available for the 3705. On-line terminal tests can be executed from the 3705 for the devices in the teleprocessing network. In addition, a diagnostic wrap facility enables the 3705 to test the line-attachment hardware to determine whether problems are in the 3705 hardware or in the communication lines.

Problem determination aids are also provided for the 3705. Instructions for using these aids will be available to the 3705 operator.

Chapter 2: 3705 Hardware Concepts

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 lines, and all 3-models have 80K of storage.

The following are the models of the 3705 with their line-attachment capability and storage capacity. Note that the line attachment indicated is only physical line attachment. The actual number of lines that the 3705 can support depends on many factors, such as line speed and throughput capability of the control program.

<i>Model</i>	<i>Maximum Line Attachment</i>	<i>Amount of Storage</i>
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

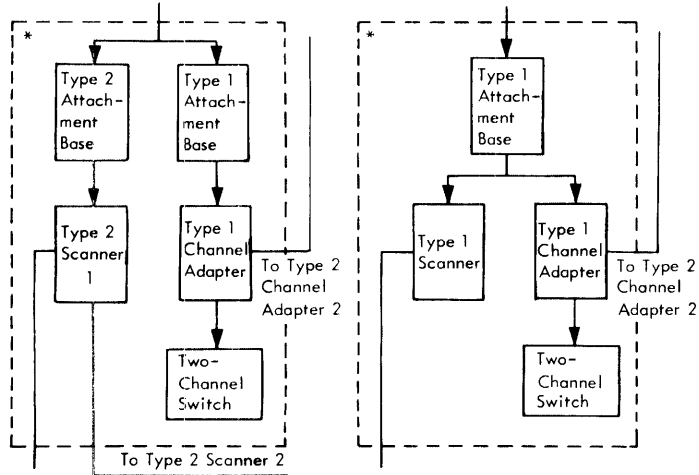
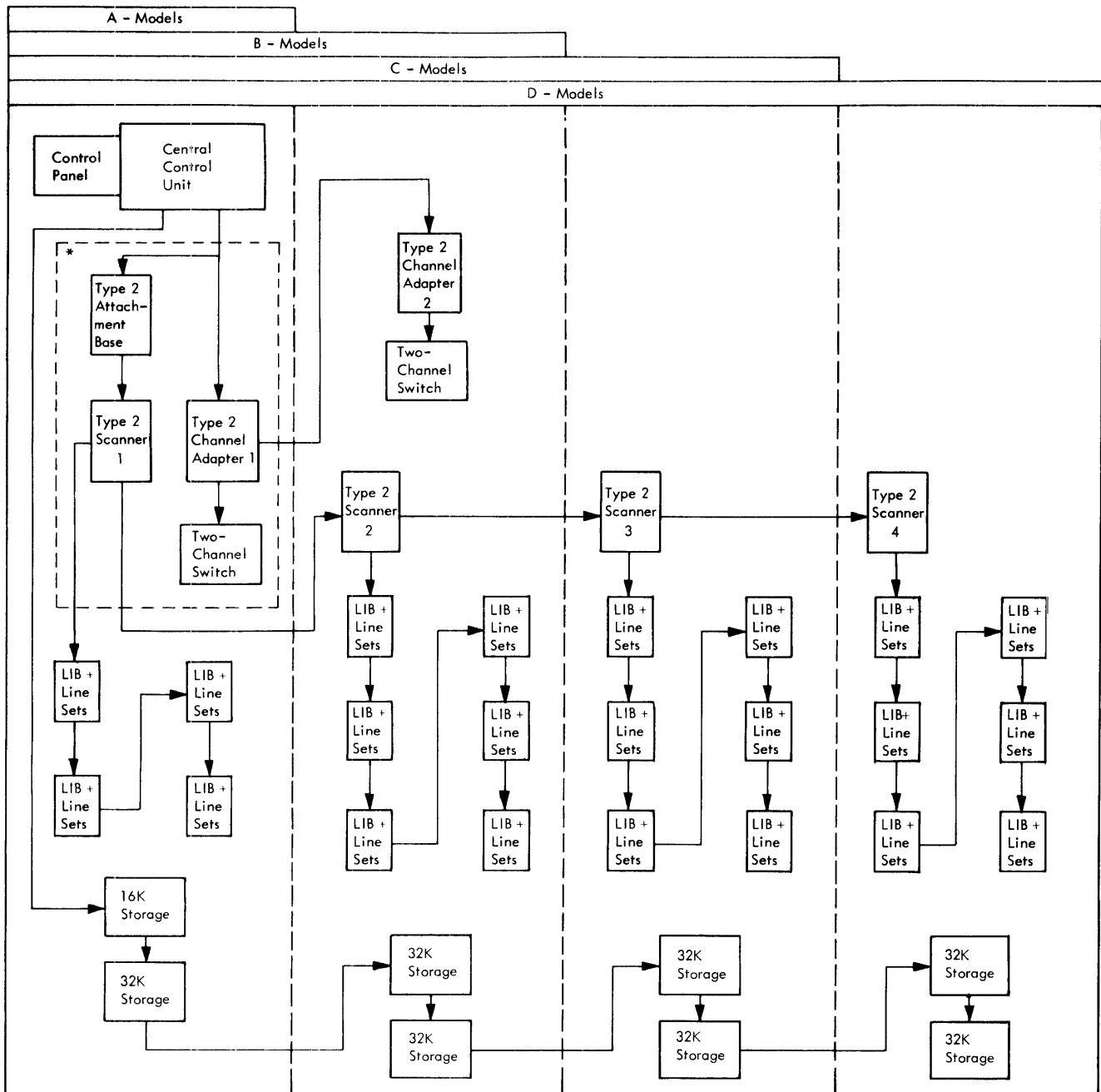
All models of the 3705 contain a Central Control Unit, a control panel, at least 16K of storage and provisions for mounting a channel adapter, a two-channel switch, a communication scanner and line interface bases and line sets to attach up to 64 communication lines. As the models increase in size, the 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 the table above.

Models of the 3705 can be upgraded to larger models at the user's installation by accomplishing a model upgrade.

Figure 3 shows the maximum configuration of the major components of the 3705 hardware. A brief description of the functions of each hardware component follows.

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 Network Control Program.



* Any of these configurations of scanners and channel adapters is possible.

Note: Only one each of the Type 1 Scanner and the Type 1 Channel Adapter is available.

Figure 3. Maximum Configuration of Major 3705 Components

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.

3705 Storage

The amount of 3705 storage ranges from 16K bytes (16,384) to 240K bytes (245,760), in 32K increments. Each model number indicates a 32K increase over the preceding number.

The 3705 Adapters

Both the communication scanners and the channel adapters (CA) for the 3705 come in two versions. The Type 1 scanner and Type 1 CA have low functional capabilities and require more control by the 3705 control program than the Type 2 adapters. The Type 2 scanner and Type 2 CA have more functional capabilities but are also more expensive.

Figure 4 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.

Combination	Number in 3705	Models
Type 1 CA Type 1 Scanner	1 1	All Models
Type 1 CA Type 2 Scanner	1 1-4	1 Type 2 Scanner - all models 2, 3, or 4 Type 2 Scanners - B, C, and D models
Type 2 CA Type 2 Scanner	1-2 1-4	1 of each - all models More than one of either or both - B, C, and D models
Type 1 CA Type 2 CA Type 1 Scanner	1 1 1	B, C, & D Models
Type 1 CA Type 2 CA Type 2 Scanner	1 1 1-4	B, C, & D Models

Figure 4. 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 interface controls to the Central Control Unit for both the Type 1 scanner and the Type 1 CA. The Type 2 Attachment Base provides common interface 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:

<i>Hardware Installed</i>	<i>Attachment Base Required</i>
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	Type 2 Attachment Base

Channel Adapters

Two 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 CA provides attachment to an IBM System/370 selector, byte-multiplexer, or block-multiplexer channel. With either adapter the 3705, running with 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.)

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 is more economical than the Type 2 CA.

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 than the Type 1 CA.

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, or one Type 1 and one Type 2 CA.

The NCP can operate with either the Type 1 or the Type 2 Channel Adapter. When two Type 2 CAs are installed, they allow attachment to two different CPUs, one of which can be designated as the primary CPU. The NCP accepts data-transfer operations only from the primary CPU. Under program control, data transfer operations can be switched to the secondary channel. The switch can be initiated over either channel. The secondary channel is then designated as the primary channel.

When both channel types are installed, the Network Control Program (NCP) can operate with either the Type 1 CA or the Type 2 CA. However, the NCP does not support both channel types simultaneously. Therefore, the non-supported channel should be disabled when the 3705 is operating in NCP mode. When the 3705 with both types of channel adapters is operating in emulation mode, the Type 2 CA should be disabled since the Emulation Program supports only the Type 1 CA.

The Two-Channel Switch Feature. Both types of 3705 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, both can have a two-channel switch. In this case, the 3705 can be attached to four channels (and, consequently, to as many as four CPUs).

Communication Scanners

The communication scanners provide the interface 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 1 scanner can handle only lines at speeds up to 4800 bps but is more economical than the Type 2 scanner.

With a Type 2 scanner, the scanner hardware assembles and disassembles characters. It interrupts the control program only when an entire character has arrived on or left from a line. The Type 2 scanner can handle lines at speeds up to 50,000 bps.

Line Interface Bases

Lines are attached to the 3705 through line interface bases (LIBs). Four different LIB types are available to handle requirements for different types of line terminations. Depending upon the type of line termination, as many as 16 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.

Lines are attached to LIBs through line sets. A single line set may provide the interface for one or two lines depending upon the type of interface. The four types of LIBs and the line sets that can be installed in them are described in *Appendix B: 3705 Line Interface Bases and Line Sets*.

Chapter 3: The System Support Programs

The IBM-supplied system support programs for the Network Control Program (NCP) are available to help you install and use the 3705. There are four system support programs: (1) the NCP generation procedure, (2) an assembler, (3) a loader, and (4) a dump program. The loader and the dump program are utility programs.

The NCP system support programs run under the IBM Operating System (OS) in a System/360 or System/370 CPU. The NCP generation procedure and the assembler are executed entirely in the CPU (not necessarily the host processor). Each of the utilities is divided into two portions, one of which runs in the host processor and the other in the 3705.

The Network Control Program Generation Procedure

The Network Control Program (NCP) generation procedure is the means by which you create the NCP that meets the requirements of your teleprocessing subsystem. To help you generate the NCP, IBM supplies (1) an NCP generation language by which you specify network configuration and NCP options, and (2) a library of macro definitions from which the source statements are expanded. The following sections describe the NCP generation macros, some NCP generation coding conventions, and how the NCP generation procedure works.

The Network Control Program Generation Language

The Network Control Program (NCP) generation language provides a high-level means for generating the Network Control Program. The language is designed to minimize the programming effort for even the most complex configuration of lines and stations.

The NCP 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 the entire 3705 Communications Controller. The parameters on these macros specify the following types of information:

- The size of 3705 storage
- The size of buffers in the Network Control Program buffer pool
- The type of channel adapter installed
- Optional facilities such as the on-line terminal test facility and the checkpoint/restart facility
- Optional dynamic control functions to be included in the Network Control Program

Configuration Macros

The configuration macros provide the information necessary to construct the tables needed by the Network Control Program to control the flow of data between the 3705 and remote stations, and between the 3705 and the host processor.

One group of these macros defines the characteristics of the elements in the teleprocessing network—line groups, lines, clusters, terminals, and components. (A cluster is a control unit, such as the IBM 2972 General Banking Terminal System, and the terminals attached to it.) You code a macro for each element in the network. The macros must be arranged in a specific order to associate a particular line with a particular line group, a particular terminal with a particular line, etc. The hierarchy from the highest level to the lowest level is: line group, line, cluster, terminal, component. So, 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
```

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 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)
- Information describing the communication scanner(s) attached to the 3705
- Definition of the remaining tables necessary to control the network (for example, lists of valid identification sequences for binary synchronous stations that call in on a switched line)

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 Network Control Program generation input stream.

Block Handling Macros

The block handling (BH) macros 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. This 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 3705 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 NCP generation time.

The remaining BH macros provide for the grouping of block handling routines into block handlers and sets of block handlers. A *block handler* is made up 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 device but before it has been determined that the line is available.
2. After a command has been received from the host access method for a teleprocessing device but only after the line is available.
3. When an input operation on a communication line ends.

Each BH set may be associated with one or more teleprocessing devices. You can associate a BH set with a device at Network Control Program generation time by coding the name of the BH set as an operand of the configuration macro that defines the device. Or, if you wish to associate a BH set with a device dynamically, or change the association of BH set and device, you can do so through a control command from the host access method.

Generation Delimiter Macro

The generation delimiter macro ends the Network Control Program generation input stream.

Coding the Network Control Program Generation Language

The Network Control Program (NCP) 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 5 illustrates the format of the input stream for a typical NCP generation.

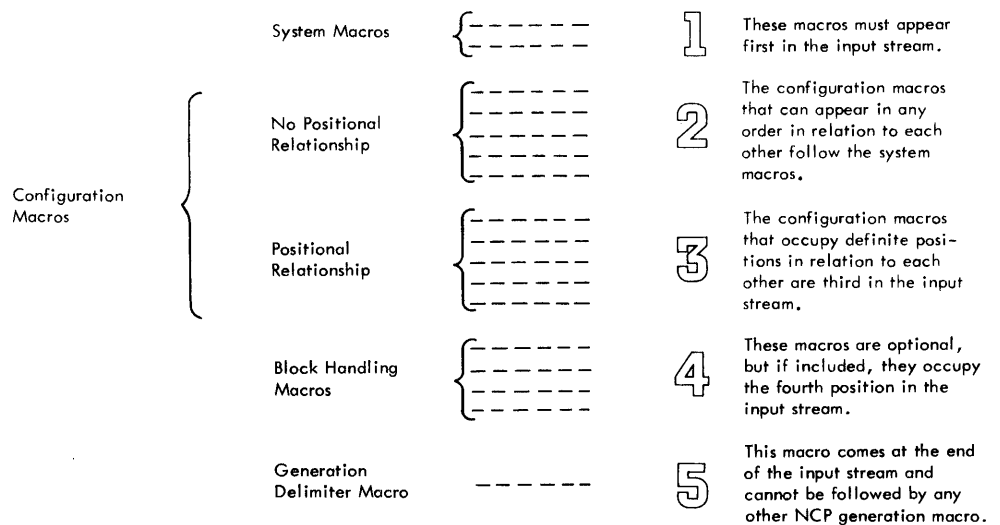


Figure 5. Format of the Input Stream for Network Control Program Generation

General Logic Flow of the Network Control Program Generation Procedure

When you have coded the Network Control Program (NCP) generation macros that describe your teleprocessing subsystem, you generate the Network Control Program using the NCP generation procedure. The NCP generation procedure is a two-stage process that runs as a series of jobs in the host processor. Figure 6 illustrates the procedure described in the following sections.

Stage One

In the first stage of the NCP generation procedure, the macros you have coded are assembled by the 3705 assembler or an OS assembler, at your option. Output from the assembly is a job stream containing the data and control statements necessary to create the desired Network Control Program. The job stream is a sequential data set that can be directed to cards, tape, or a direct access storage device.

Intervention Between Stages of Network Control Program Generation

Intervention is required between stages of the NCP 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, no job stream is created, and the source statements must be resubmitted until these errors are corrected.

If there are no severe assembly errors, you initiate the second stage of NCP generation, specifying as input the job stream created during stage one.

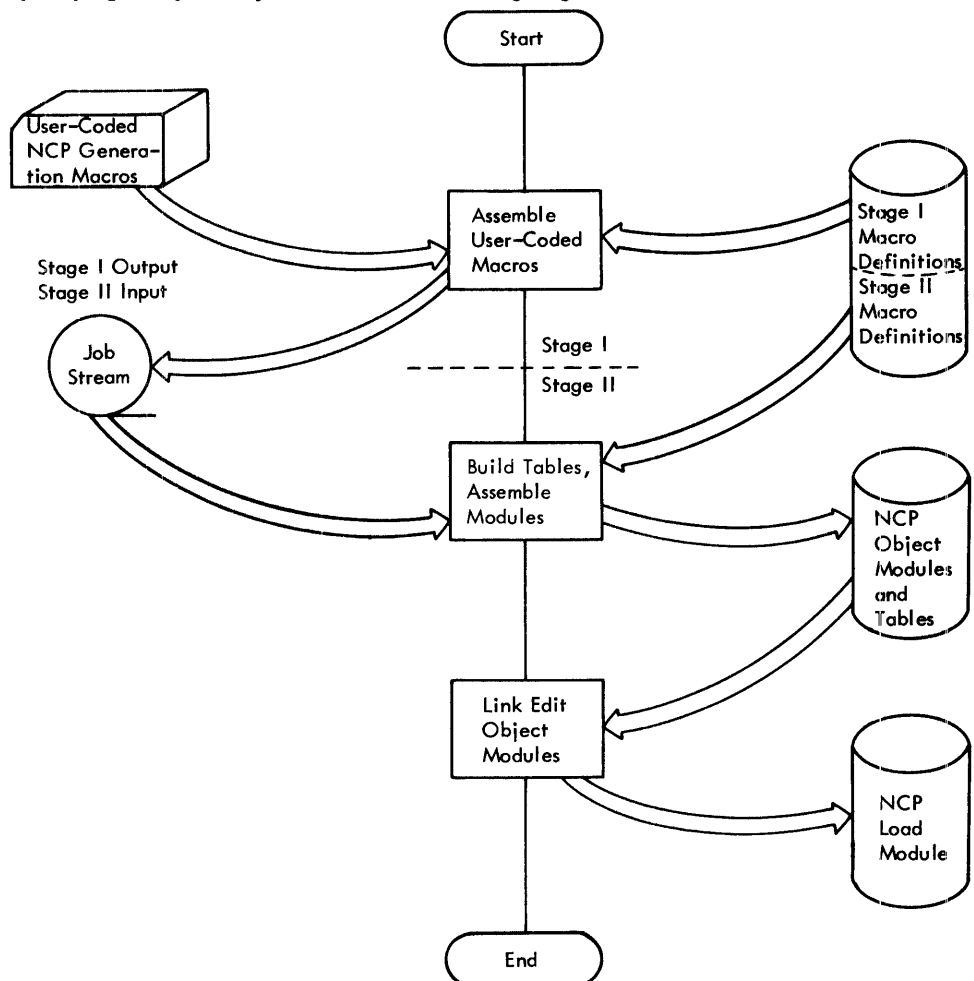


Figure 6. The Network Control Program Generation Procedure

Stage Two

The second stage of NCP generation creates the NCP that will support the teleprocessing subsystem and perform the processing functions that you have specified. The job stream from stage one contains the data necessary to select the appropriate NCP modules and build the proper NCP tables.

Using the information you coded in the NCP generation macros, stage two first builds the tables, then assembles the modules that are dependent on the network you define. Then the OS Linkage Editor is executed to combine the appropriate modules into the NCP load module. Finally, the load module is stored on a direct access storage device.

Generating Multiple Network Control Programs

You can generate as many Network Control Program (NCP) load modules for the IBM 3705 as you wish. Each NCP requires a separate NCP generation, and each must have a different symbolic name in order that the loader can identify the load module to be transferred into the 3705.

Multiple NCP load modules are useful for installations that have several distinct applications for the teleprocessing subsystem. For example, if your installation runs only start-stop 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 3705 and make the program operation more efficient.

The 3705 Assembler

The 3705 assembler is available to assemble programs written in 3705 assembler language. In its external structure, it is very similar to the OS assemblers.

The 3705 assembler operates on three kinds of instructions; (1) 3705 machine instructions (written in 3705 assembler language notation); (2) 3705 macro instructions; and (3) 3705 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 parallel the types of instructions processed by the OS assemblers.

The 3705 Instruction Set

The 3705 instruction set 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 3705 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.

Macro Capability of the 3705 Assembler

The 3705 macro language is an extension of the 3705 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 3705 Assembler Instructions

Instructions to the 3705 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 3705 Assembler

The uses of the 3705 assembler include: (1) preassembling user-written block handling routines, and (2) assembling the NCP generation macros and application-dependent modules during the NCP generation procedure.

The assembler enables you to add to the IBM-supplied routines block handling routines (BHRs) that are unique to your applications. Using the 3705 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 NCP object modules. At NCP 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 NCP load module.

The Utilities

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

The Loader

The loader has two loading functions: (1) it transfers a diagnostic routine, the *initial test* routine, into the 3705, and (2) it transfers the Network Control Program from host secondary storage into the 3705.

The loading of the initial test routine occurs before the NCP is loaded into the 3705. This routine tests the hardware for conditions that could possibly result in failure of the 3705 after operation begins. If the initial test routine discovers any exceptional conditions, it causes a hard stop of the 3705, and cancels transfer of the NCP into the 3705. Indicators on the 3705 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 NCP 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 3705 fails because of some error condition. The operator starts the loader in this case, too.

This should not imply, however, that IPL (Initial Program Load) of the 3705 is always performed by the loader. TCAM, for example, has its own loading facility which can automatically reload the NCP if the 3705 fails. Therefore, the second instance in which the loader is invoked applies only when the automatic IPL facility is not included in 3705 access method support.

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 NCP load module from secondary storage and issues a Write command for each block of NCP code to be transferred across the channel into the 3705.

The 3705 portion of the loader initializes the 3705 to prepare it for the data written from the host processor. It then communicates with the host portion, accepting blocks of the NCP load module from the channel and positioning them appropriately in 3705 storage.

The Dump Program

The dump program dumps the contents of 3705 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 of 3705 storage.
- You can request a formatted dump of the Network Control Program (NCP). In this case, the dump program isolates and labels certain NCP control blocks, printing them at the beginning of the dump.
- You can request that the mnemonic operation codes for all 3705 machine instructions be interleaved with the instructions in the dump.

Both formatted and unformatted dumps contain a hexadecimal representation of 3705 storage. In addition, all dumps include the contents of the general registers and the EBCDIC representation of all letters and numbers in the dump.

How the Dump Program Operates

The dump program has two job steps. The first step, which requires code in both the host processor and the 3705, dumps the entire contents of 3705 storage and the contents of the general registers to a data set on host disk storage.

The first step of the dump program automatically invokes the second step, which runs entirely in the host processor. This step first analyzes the utility control cards, on which you have specified the limits of 3705 storage to be printed out and whether the printout is to be formatted or unformatted. (You may request a printout of as many 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 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.

After a dump, the 3705 is idle and must be reloaded before it can operate again.

Chapter 4: Network Control Program Concepts

The Network Control Program (NCP) is a program that resides in 3705 storage and controls the transfer of data between the stations in a teleprocessing network and the host processor. In order to run the NCP, at least a 2-model of the 3705 (48K storage) must be installed.

The primary functions of the NCP are related to the transmitting and receiving of data. In addition, the NCP can perform optional functions to process the data passing through the 3705. These are primarily editing functions that can be performed before data is transmitted to a station during an output operation or before it is sent to the host processor during an input operation.

Finally, the NCP includes routines to attempt error recovery, to record error statistics, and to perform diagnostic tests. These functions enable the NCP to correct many line errors without user intervention. When irrecoverable errors occur, these functions aid in finding the source and correcting the error.

In performing its functions, the NCP 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 7 illustrates data flow from the station to the CPU through the various components of the 3705.

The NCP 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 3705 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 NCP, or by the NCP to respond when an operation is complete.

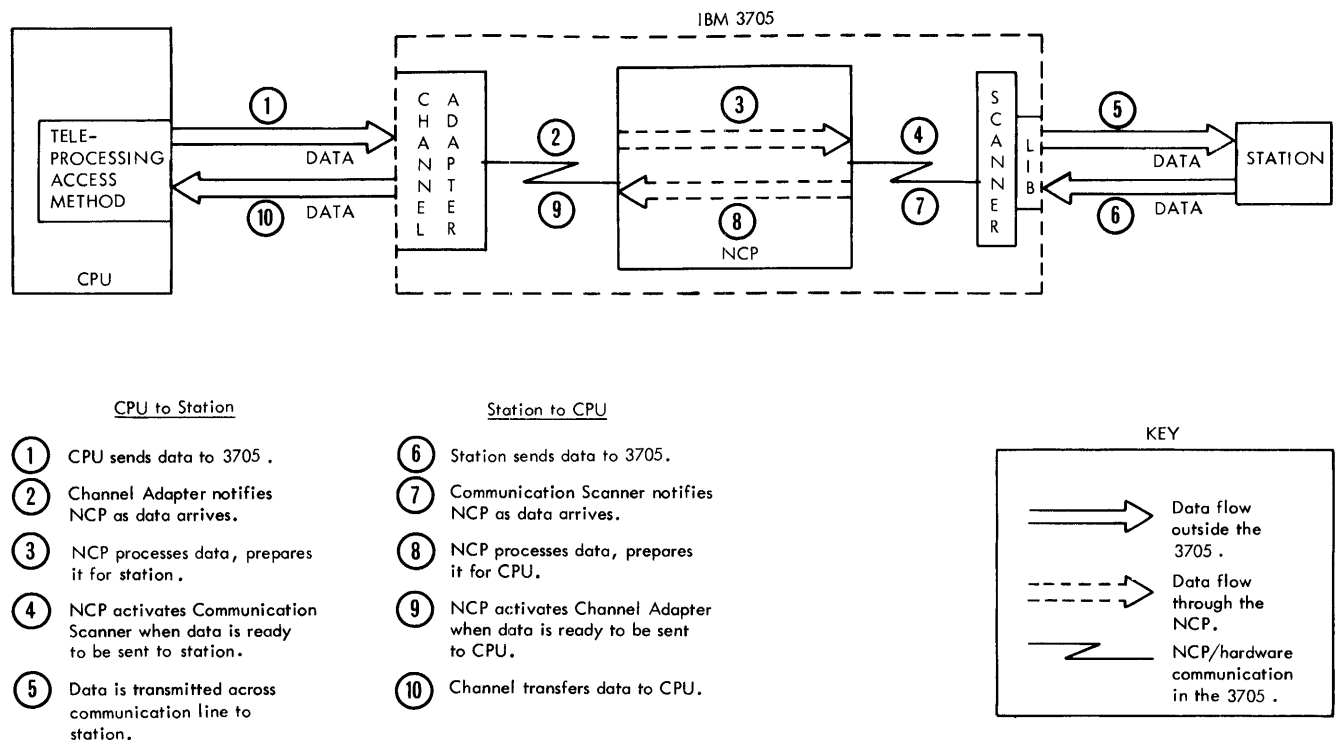


Figure 7. Data Flow between CPU and Station through the IBM 3705.

Figure 8 shows how the NCP and the access method communicate with each other. The attached data is optional, depending on the operation.

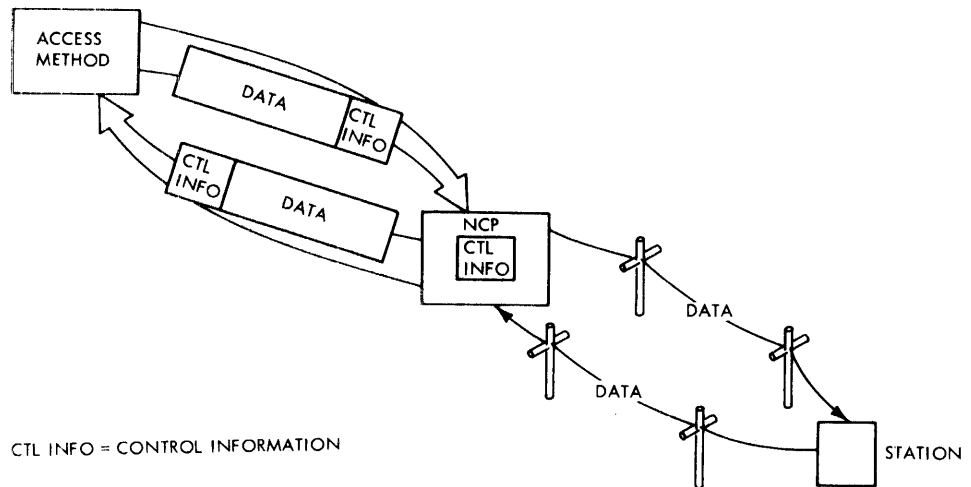


Figure 8. Logical Data Flow between the Access Method and the Network Control Program

Functions of the Network Control Program

The Network Control Program (NCP) performs a wide range of functions for the teleprocessing subsystem. Certain functions are standard features for any NCP; others are optional functions, selected as part of the NCP generation procedure.

Standard Functions

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

Communication Control Functions

The NCP 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 devices on multipoint lines and point-to-point lines where the terminal has multiple components.
- Dialing and answering stations on switched lines.
- Character or Bit Service. The NCP is interrupted whenever a character or a bit arrives on a line. (Whether the interrupt occurs for each bit or for each character depends upon the type of scanner installed.) When the interrupt occurs, the NCP moves the character or bit into a buffer.
- Control Character Insertion and Deletion. The NCP inserts line 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.
- Character Code Translation. As data arrives on a line, it is automatically translated by the NCP from transmission code into EBCDIC. Likewise, EBCDIC data is translated automatically into transmission code before being transmitted to a station.
- Dynamic Buffering. The NCP allocates buffers from 3705 storage as it receives data from a station or from the host processor. It accumulates an entire block of data before transferring any data to the host processor.

Error Recording and Diagnostic Functions

The NCP maintains several types of error records and provides display capabilities for diagnostic purposes. These functions include:

- **Hardware- and Program-Check Recording.** The NCP keeps a record of hardware- and program-check errors, transferring the information to the host processor whenever possible. If transfer is impossible (for example, if the channel hardware fails), the NCP program displays the type of error on the 3705 control panel.
- **Permanent Line Error Recording.** If normal error recovery procedures fail to recover from a line error, the NCP transfers a record containing information about the error to the host processor.
- **Statistics Recording.** The NCP maintains for each device a count of the number of I/O operations and the number of temporary errors that occur for that device.
- **Dynamic Panel Displays.** This function of the NCP permits the operator to display storage areas, register contents, or control information on the 3705 control panel.

Optional Functions

Many of the capabilities of the NCP are optional; they may be performed by the host access method, or they may be omitted entirely, depending upon your needs. You select the options that meet your needs when you generate the NCP. Some options are automatically included in the NCP unless you specify that they are to be omitted. Others are omitted unless you specify that they are to be included.

The following are optional functions:

Block Processing Functions

The NCP can perform processing functions on blocks of data from either the terminal or the host processor. You can select the following block processing functions:

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

Additional block-processing functions are possible through routines that you write and assemble with the 3705 assembler. These routines are included in the NCP by coding an NCP generation macro designed for that purpose.

These functions are described in more detail in the section, *Block Handling Macros*, in Chapter 3 of this publication.

Error Recovery and Diagnostic Functions

- **Critical Situation Notification.** The NCP can notify stations when the host processor or channel fails. You define the message to be sent to stations when a critical situation arises.
- **Address Trace.** The operator can request through the 3705 control panel that the NCP display four variables (storage areas and/or registers) when a certain address in 3705 storage is accessed. This function provides a dynamic trace facility for diagnostic purposes.
- **Checkpoint/Restart Support.** The NCP works with the host access method to provide the checkpoint/restart facility. The NCP generates checkpoint records when they are requested by the access method. The access method then consolidates and stores the records.
- **On-Line Terminal Tests.** On-line terminal testing (OLTT) facilities are available through the 3705. The NCP provides support for the OLTT functions by recognizing test requests from teleprocessing devices and executing test programs constructed by an OLTT program in the host processor.

- **Pause-Retry.** When a transmission error occurs, the NCP tries to retransmit the data after an interval that you specify. You also specify the maximum number of retries for each device. This function is included for all devices unless you specify that no retries are to be made.
- **Alternate Path Retry.** For certain device types, you can specify an alternate line to be used if the primary line encounters an error from which normal error recovery procedures fail to recover.

Dynamic Control Functions

The NCP 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 NCP by specifying them at NCP generation time. The dynamic control functions include:

- **Activation and deactivation of devices, lines, and groups of lines.** Commands from the access method request the NCP to activate or deactivate a device, a line, or a line group attached to the 3705. The deactivation facilities allow you to perform an orderly closedown of the teleprocessing network.
- **Displaying any 32 contiguous bytes of 3705 storage.** The requested bytes are sent to the host processor.
- **Requesting the status of a line or device.**
- **Switching channel adapters.** The NCP can support two Type 2 channel adapters attached to two different CPUs. This function causes the NCP to switch to the secondary channel adapter upon receipt of a command from the host access method.
- **Replacing device ID characters and polling and addressing characters.**
- **Changing the order in which devices on a line are polled and addressed.**
- **Changing the number of consecutive times a device can respond negatively to polling before the line is rescheduled for other operations.**
- **Changing the block processing routines for data associated with a device.**
- **Setting the time and date in the 3705.**
- **Changing the maximum number of data transmissions between the host processor and a device on a multipoint line before the NCP tries to service other devices on the line.**

The Network Control Program Commands

The Network Control Program (NCP) recognizes and executes four kinds of commands: (1) the Teleprocessing (TP) commands, which initiate and control the activity on the communication lines; (2) the Control commands, used to modify and control parameters in the NCP; (3) the Test command, which initiates testing functions in the NCP; and (4) the Restart command, which requests that the 3705 be restarted using the latest checkpoint records.

All the NCP commands originate from the host access method, which conveys them to the NCP in the field of control information. A description of each of the four kinds of commands and their functions follows.

The Teleprocessing Commands

The NCP recognizes six commands that control activity on the communication lines. These commands are called the Teleprocessing (TP) commands. They are used to establish and terminate contact with teleprocessing devices and to regulate the transfer of data over the communication lines.

The TP commands are structured to relieve the host access method of as many device- and line-type dependencies as possible. All of the TP commands are valid for all line types. They always perform the same logical function, and although the physical operations involved may be unique to a particular line type, the NCP, not the access method, is responsible for recognizing and handling most line-dependent factors.

The TP commands are valid only for devices identified at NCP generation time as terminals or components. Thus, the access method needs to be concerned only with individual devices and not with lines or line types.

The TP commands and their basic functions are:

Invite—enables the teleprocessing device to send data to the host processor, and transfers one unit of data from the device to the host processor.

Contact—enables the host processor to send data to the device.

Read—transfers a unit of data from the device to the host processor.

Write—transfers a unit of data from the host processor to the device.

Disconnect—breaks the current connection with the device.

Reset—dynamically alters the sequence of commands in the NCP for a device. The Reset command provides a number of different facilities, some of which are standard and some of which are selected at NCP generation time.

Data Units

At NCP generation time you define the unit of data to be transferred by each Read command for a teleprocessing device. The data units recognized by the NCP are as follows:

1. *Block*: A block of data is the smallest unit recognized by the NCP. For start-stop devices, it is the unit of data that begins and ends with an EOB character. For BSC devices, it is the unit beginning and ending with ETB or ETX characters.
2. *Message*: For BSC devices, the message is the data unit from the beginning of the transmission to the first ETX character, or a data unit that begins and ends with an ETX character. For start-stop devices, the message and the transmission have the same meaning.
3. *Transmission*: A transmission is the largest single data unit a teleprocessing device can transmit to the 3705. It begins with a **D** and ends with a **C** for start-stop devices. For BSC devices, it begins with an SOH or STX character and ends with an EOT character.

TP Command Modifiers

All of the TP commands except the Contact command have modifiers that expand the meaning of that command. The meanings assigned to the various modifiers include the following:

- Override the data unit (block, message, or transmission) specified at NCP generation time with another data unit for this command.
- Combine this command with another command. (The second command is executed automatically as a result of the modifier for the first command and does not require another communication from the access method.)
- Insert a particular line control character at the end of this block of data.

The Control Commands

The Control commands request the NCP to modify parameters of the teleprocessing subsystem or to provide status information dynamically during NCP execution.

There are three Control commands, each of which requests a different type of control function from the NCP. The particular function is specified by a modifier to the command. The three Control commands are:

- Special control—functions such as switching channel adapters and displaying 3705 storage.
- Network definition control—functions such as activating and deactivating devices.
- Scheduling control—functions such as changing the retry limit or the negative poll response limit.

Some of the control functions that can be requested by the Control commands are described in the section, *Functions of the Network Control Program*, in this chapter.

The Test Command

The Test command indicates that an on-line terminal test is to be performed for the teleprocessing device whose ID is specified in the control field. The control field containing the Test command is accompanied by a series of interpretive commands to be executed by the NCP. The sequence of these commands is determined by an on-line terminal test program in the host processor.

The Restart Command

The Restart command requests that the 3705 be restarted using the most current checkpoint information. When the 3705 is to be restarted, the host access method issues a series of Restart commands, each accompanied by a checkpoint record. These records are used by the NCP to restore the lines and devices to the status that existed before closedown of the 3705 occurred.

The Restart command is valid only if the checkpoint/restart option is included in the NCP. The NCP can accept a Restart command after normal IPL of the 3705 or after automatic closedown of the network due to a failure in the system. As soon as the NCP receives a TP or Control command, it rejects any subsequent Restart commands as invalid.

The Session

The access method communicates with a teleprocessing device attached to the 3705 within the context of a *session*. A session is defined as a sequence of command and data interchanges between the host processor and the device. The NCP mediates the sequence of interchanges in the session.

The access method starts and ends a session by issuing a command to the NCP. The NCP interprets and executes the command for the access method. Between the commands that start and end a session, the access method issues commands to transfer data to or from the device.

Starting and Ending a Session

To start a session with a teleprocessing device, the access method issues either a Contact command or an Invite command. A Contact command is issued when the host processor has data to send to the device. An Invite command allows the device to send data to the host processor.

The Contact and Invite commands establish a connection with a device that allows the NCP to execute data-transfer commands for that device.

To end a session, the access method issues a Disconnect command.

Transferring Data

When a connection with a device has been established by a Contact or an Invite command, the access method issues either a Write or a Read command to transfer data to or from the device.

A Write command transfers data from the 3705 to the device. A series of Writes must be preceded by a Contact command.

A Read command transfers data from the device to the 3705. A series of Reads must be preceded by an Invite command.

Sessions on Multipoint Lines

The general concept of the session is the same for any type of line. However, for multipoint lines and point-to-point lines where the terminal has multiple components, some additional concepts pertaining to the session are introduced.

Service Seeking

The NCP tries to start sessions with teleprocessing devices on multipoint lines (or on point-to-point lines where the terminal has multiple components) by means of a process called *service seeking*. Service seeking combines polling and addressing into a single operation by handling both Contact and Invite commands.

The NCP requires a *service order table* for each line for which service seeking is required. The service order table is a list of the devices on the line in the order in which they are to be interrogated by the NCP. A device can appear in the list many times. You define the service order table at the time you generate the Network Control Program.

Service seeking attempts to establish sessions with devices in the order specified in the service order table. When a device responds positively to service seeking, a session with that device begins.

Session Limit

The service-seeking mechanism allows the NCP to conduct several sessions concurrently on a multipoint line. That is, the NCP can initiate a session with a device while sessions with one or more other devices on the same line are still in progress.

The maximum number of concurrent sessions allowed on a line is called the *session limit*. You can specify as a parameter of the NCP generation language the session limit for each line on which service seeking is employed. The NCP will then try to maintain the specified number of sessions on the line at all times.

When multiple sessions are initiated on a line, only one device at a time actually has control of the line. But the NCP periodically suspends the current session either (1) to give control to another device for which a session has been started, or (2) to try to establish new sessions through service seeking if the session limit for the line has not been reached. In this way the data from the various devices is interleaved so that the data transfer appears to the access method to be simultaneous.

Transmission Limit

You can control the amount of time the NCP spends servicing a particular device by setting a *transmission limit* for the device. The transmission limit specifies the maximum number of transmissions that will be sent to or received from a device during a session before the NCP suspends the session to service other devices on the line. This facility ensures that one device does not monopolize the line and prevent other devices on the line from sending or receiving data.

Service Seeking Pause

If no sessions are currently established on a line, the NCP pauses between successive attempts at service seeking on the line. This function reduces the overhead necessary for the service-seeking activity. As an NCP generation option, you can define the number of seconds to be paused between attempts.

Chapter 5: Emulation Program Concepts

The Emulation Program (EP) allows the 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 EP allows many programs written for support of the 2701, 2702, and 2703 to operate with the 3705 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 EP requires that a Type 1 Channel Adapter be installed in the 3705 for attachment to a System/360 or System/370 byte-multiplexer channel. The minimum storage requirement for the EP is 16K.

The EP 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 2712 attachment features.

In addition to the standard 2701-2702-2703 functions, the EP also supports certain RPQs (Requests for Price Quotation) for these control units.

In emulation mode, the 3705 can attach up to 255 half-duplex 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 3705 in emulation mode requires a nonshared subchannel address on the byte-multiplexer channel.

Appendix D lists the teleprocessing devices supported by the 3705 with the Emulation Program.

Although the Emulation Program is a stand-alone program, operation of the EP can alternate with operation of the NCP if the 3705 has sufficient storage to support the NCP. Switching from one control program to the other requires that the 3705 be re-IPLed.

Emulation Support Programs

Support for the Emulation Program is provided under both the Operating System (OS) and the Disk Operating System (DOS). The EP generation language is a subset of the NCP generation language, with a few additional parameters necessary for the Emulation Program. The EP generation procedure operates like the NCP generation procedure, with minor changes in the DOS procedure to accommodate differences in OS and DOS.

The OS assembler and utility programs (loader and dump program) used for the NCP can also be used for the EP. An assembler, a loader, and a dump program are also provided for DOS support of the EP. These programs are functionally similar to the OS programs.

For more detail on the support programs, see *Chapter 3: The System Support Programs*.

Appendix A: Devices Supported by the IBM 3705 Communications Controller with the Network Control Program

Start-Stop Terminals

IBM 1050 Data Communication System
IBM 2740 Communications Terminal, Models 1 and 2
IBM 2741 Communications Terminal
IBM System/7 (supported as an IBM 2740 Communications Terminal, Model 1, with the Record Check feature)

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
IBM 3735 Programmable Buffered Terminal

Transmission Control Units (BSC support only)

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

Note: *The IBM 2701, IBM 2703, and IBM 3705 control units are supported only when attached locally to an IBM System/360 or System/370.*

Computers (BSC support only)

IBM 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)
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 Network Control Program also communicates with the following.

- A. World Trade teleprinters that use CCITT #2 or #5 code on leased point-to-point 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; AT & T CPT-TWX (33/35) start-stop code over switched lines.

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

Appendix B: 3705 Line Interface Bases and Line Sets

Line interface bases (LIB) provide for the attachment of lines to the 3705. Four different LIB types are available for the 3705. The types of LIBs and the kinds of line sets through which lines can be attached to each are as follows:

LIB Type 1. The LIB Type 1 provides for the attachment of up to eight of the following line sets in any combination.

1. Line Set 1A (Low-Speed External Modem)—This line set provides for the attachment of two start-stop lines at speeds up to 1200 bps, each of which has an EIA RS-232-C/CCITT V24 interface for attachment to an external data set. 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 3979 Model 2 (not available in the United States and Canada)

2. 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. Data sets are not required.
3. Line Set 1D (Medium Speed External Modem)—This line set provides for the attachment of two start-stop or synchronous lines at speeds up to 4800 bps, each of which has an EIA RS-232-C/CCITT V24 interface for attachment to an external data set. The IBM modems with which this line set can operate include those mentioned under Line Set 1A.
4. Line Set 1E (Autocall Adapter)—This line set has two EIA RS-366 interfaces for attachment of two external automatic calling units. These automatic calling units may be associated with any switched-network lines attaching through Line Sets 1A, 1D, or 1G. This line set is available only in the United States and Canada.
5. Line Set 1F (Medium Speed Local Attachment) —This line set provides for the local attachment of two IBM start-stop or synchronous terminals at speeds up to 2400 bps via IBM-provided cables. Data sets are not required.
6. Line Set 1G (High Speed External Modem)—This line set provides for the attachment of one synchronous line for operation at 19,200 bps, 40,800 bps, or 50,000 bps. This line set has a digital interface for attachment to a switched or leased wideband external data set. This line set is available only in the United States and Canada.

LIB Type 2. The LIB Type 2 provides for the attachment of up to eight line sets for telegraph termination. Only one type of line set is available for LIB Type 2.

1. Line Set 2A (Telegraph Single Current)—This line set provides for the attachment of two single-current telegraph lines, each of which 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 up to six of the following line sets in any combination.

1. Line Set 3A (Limited Distance Type 1 Modem, 2-wire)—This line set provides for the attachment of two start-stop lines at speeds up to 134.5 bps. The line set includes two IBM Limited Distance Type 1 (2-wire) line adapters. No external data sets are required.
2. Line Set 3B (Limited Distance Type 1 Modem, 4-wire)—This line set provides for attachment of two start-stop lines at speed up to 134.5 bps. This line set includes two IBM Limited Distance Type 1 (4-wire) line adapters. No external data sets are required.

LIB Type 4. The LIB Type 4 provides for the attachment of up to two of the following line sets in any combination.

1. Line Set 4A (Limited Distance Type 2 Modem)—This line set provides for the attachment of two start-stop lines at speeds up to 600 bps. The line set includes two IBM Limited Distance Type 2 line adapters. No external data sets are required.

2. Line Set 4B (Leased Line Modem, 2-wire)—This line set provides for the attachment of two start-stop lines at speeds up to 600 bps. The line set includes two IBM Leased Line (2-wire) line adapters. No external data sets are required.
3. Line Set 4C (Leased Line Modem, 4-wire)—This line set provides for the attachment of two start-stop lines at speeds up to 600 bps. This line set includes two IBM Leased Line (4-wire) line adapters. No external data sets are required.

Appendix C: 3705 Line-Set to Data-Set/Autocall-Unit Interfaces

Signal Name	EIA/CCITT	Pin#	3705 Line Set		
			1A	1D	1E
Signal Ground	AB/102	7	STD	STD	N/A
Transmitted Data	BA/103	2	STD	STD	N/A
Received Data	BB/104	3	STD	STD	N/A
Request to Send	CA/105	4	STD	STD	N/A
Clear to Send	CB/106	5	STD	STD	N/A
Data Set Ready	CC/107	6	STD	STD	N/A
Data Terminal Ready	CD/108*	20	STD	STD	N/A
Ring Indicator	CE/125	22	N/A	OPT	N/A
Received Line Signal Detector	CF/109	8	OPT	OPT	N/A
Data Signal Rate Selector	CH/111	23	N/A	OPT	N/A
Transmitter Signal Element Timing	DB/114	15	N/A	OPT	N/A
Receiver Signal Element Timing	DD/115	17	N/A	OPT	N/A
New Sync	Special	14	N/A	OPT	N/A
Signal Ground	AB/201	7	N/A	N/A	STD
Digit Present	DPR/211	2	N/A	N/A	STD
Abandon Call and Retry	ACR/205	3	N/A	N/A	STD
Call Request	CRQ/202	4	N/A	N/A	STD
Present Next Digit	PND/210	5	N/A	N/A	STD
Power Indication	PWI/213	6	N/A	N/A	STD
Call Origination Status	COS/204	13	N/A	N/A	STD
Digit #1	NB1/206	14	N/A	N/A	STD
Digit #2	NB2/207	15	N/A	N/A	STD
Digit #3	NB3/208	16	N/A	N/A	STD
Digit #4	NB4/209	17	N/A	N/A	STD
Data Line Occupied	DLO/203	22	N/A	N/A	STD

*Circuit CD/108 is available in the Connect-Data-Set-to-Line option (CCITT 108.1) or the Data-Terminal-Ready (CCITT 108.2) option.

STD signals are those signals that the line set always presents to or expects to receive from the external modem or autocal unit.

OPT signals are those signals that the line set is capable of presenting to or receiving from the external modem or autocal unit, but whose use is dependent upon the type of modem, communication facility, program support, etc., used.

N/A are those signals Not Available on the line set. Signals not listed are also Not Available.

Appendix D: Devices Supported by the IBM 3705 Communications Controller with the Emulation Program

Start-Stop Terminals

IBM 1030 Data Collection System
IBM 1050 Data Communication System
IBM 1060 Data Communication System
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)
IBM System/7 (supported as an IBM 2740 Communications Terminal, Model 1, with the Record Check feature)

Binary Synchronous Terminals

IBM 2770 Data Communications System
IBM 2780 Data Transmission Terminal (no support for Transcode)
IBM 2845/2265 Display Complex
IBM 2848/2260 Display Complex
IBM 2972 General Banking Terminal System, Models 8 and 11
IBM 3270 Information Display System
IBM 3670 Brokerage Communication System (supported only in the United States and Canada)
IBM 3735 Programmable Buffered Terminal

Transmission Control Units (BSC support only)

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

Note: *The IBM 2701, IBM 2703, and IBM 3705 control units are supported only when attached locally to an IBM System/360 or System/370.*

Computers (BSC support only)

IBM 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 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 Emulation Program also communicates with the following.

- A. World Trade teleprinters that use CCITT #2 or #5 code on leased point-to-point, leased multipoint, or switched network 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; AT & T CPT-TWX (33/35) start-stop code over switched lines.

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

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

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

Alternate path retry. An optional facility of the NCP that allows the user to specify for certain device types a line to be used as a backup line if the primary line becomes unavailable due to an irrecoverable error.

Attachment base. A 3705 hardware feature that provides the interface controls to the Central Control Unit for the 3705 adapters.

Bit service. The process of character assembly or disassembly.

Block. The smallest data unit recognized by the 3705. For start-stop devices, a unit of data between two EOB characters; for BSC devices, a unit between two ETB or ETX characters.

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 NCP.

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

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

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

Buffer. A temporary storage area for data.

Central Control Unit. The 3705 hardware unit that contains the circuits and data flow paths needed to execute the 3705 instruction set and to control 3705 storage and the attached adapters.

Channel adapter (CA). A 3705 hardware unit that provides attachment of the 3705 to a System/360 or System/370 channel.

Character assembly. The process by which bits are put together to form characters as the bits arrive on a communication line. In the 3705, character assembly is performed either by the NCP 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 3705, character disassembly is performed either by the NCP 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 allows a program to return to a previous point and resume execution there on the basis of information stored at that point when execution was suspended.

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

Communication scanner. A 3705 hardware unit that provides the interface 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 NCP generation macros that provide information necessary to construct the tables needed by the NCP to control the flow of data between the 3705 and stations and between the 3705 and the host processor.

Contact. An NCP Teleprocessing command that starts a session with a teleprocessing device by making it possible for the host processor to send data to the device.

Control command. An NCP command by which the access method requests that the NCP perform a dynamic control function for the teleprocessing subsystem. The particular function is specified by a modifier of the Control command.

Cycle steal. The process by which the Type 2 Channel Adapter acquires machine cycles from the 3705 control program for data transfer.

Device. (See **Teleprocessing device.**)

Disconnect. An NCP Teleprocessing command that ends a session and breaks the connection with the teleprocessing device.

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 NCP functions initiated by a Control command from the host access method.

Element. A part of the teleprocessing network defined by an NCP generation macro. Possible elements are line groups, lines, clusters, terminals, and components.

Emulation Program (EP). A control program that allows the 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 NCP control blocks are isolated and identified.

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

Hard stop. Immediate termination of 3705 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 3705 is attached by a channel and that executes the teleprocessing access method that supports the 3705.

Initial test routine. A diagnostic program executed in the 3705 before the NCP is loaded. The initial test routine tests the 3705 hardware for conditions that might cause failure after operation begins.

Interrupt. A halt in processing that allows processing to be resumed at the place it left off.

Invite. An NCP Teleprocessing command that starts a session with a teleprocessing device by allowing the device to send data to the host processor.

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 3705.

Line interface base (LIB). A 3705 hardware unit that provides for the attachment of up to 16 communication lines to the 3705.

Line scanner. (See **Communication scanner**.)

Line set. A 3705 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.

Message. For BSC devices, the data unit from the beginning of the transmission to the first ETX character, or between two ETX characters; for start-stop devices, *message* and *transmission* have the same meaning.

NCP. (See **Network Control Program**.)

NCP generation language. The set of macro instructions and associated operands by which the 3705 user defines the network configuration and operating parameters of the teleprocessing subsystem.

NCP generation procedure. A two-stage process that creates an NCP load module based on parameters specified by the user through the NCP generation language.

Network Control Program (NCP). A control program for the 3705, 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.

Pause-retry. An NCP option that allows the user to specify how many times the NCP should try to retransmit data after a transmission error occurs, and how long the NCP should wait between each attempt.

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

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

Record. A group of related data items treated as a unit.

Reset. An NCP Teleprocessing command that dynamically alters the sequence in which commands for a device are executed in the 3705.

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

Restart command. An NCP command that requests that the 3705 be started using the most recent checkpoint records.

Service order table. The list of teleprocessing devices on a multipoint line (or point-to-point line where the terminal has multiple components) in the order in which they are to be serviced by the NCP.

Service seeking. The process by which the NCP interrogates teleprocessing devices on a multipoint line (or point-to-point line where the terminal has multiple components) for requests to send data or for readiness to receive data.

Service-seeking pause. A user-specified interval between successive attempts at service seeking on a line when all teleprocessing devices on the line are responding negatively to polling.

Session. A series of command and data interchanges between the host processor and a teleprocessing device.

Session limit. The maximum number of concurrent sessions that can be initiated on a multipoint line (or point-to-point line where the terminal has multiple components).

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

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

System macro. One of the NCP generation macros that provide information pertaining to the entire 3705.

Teleprocessing. A form of information handling in which a data processing system utilizes communication facilities.

Teleprocessing command. One of the NCP commands that control the activity on the communication lines.

Teleprocessing device. A unit of teleprocessing equipment connected to the 3705 via a communication line and identified as a cluster, terminal, or component at NCP generation time.

Teleprocessing network. The stations that are controlled by a single access method (or, in the 3705, by a single NCP), and the communication lines by which they are connected 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, data sets (or modems), communication lines, and the transmission control unit.

Terminal. A teleprocessing device capable of transmitting or receiving data (or both) over a communication line.

Test command. An NCP command that indicates that an on-line terminal test is to be performed for the teleprocessing device specified in the control information from the host access method.

TP command. (See **Teleprocessing command.**)

Transmission. For start-stop devices, the data unit between a Ⓓ and a Ⓒ line control character; for BSC devices, the data unit between an SOH or STX character and an EOT character.

Transmission code. The character code used for data transmissions across a communication line.

Transmission Control Unit (TCU). A unit that provides the interface between communication lines and a computer. The TCU interleaves the transfer of data from many lines across a single channel to the computer.

Transmission limit. The maximum number of transmissions that can be sent to or received from a teleprocessing device during one session on a multipoint line (or point-to-point line where the terminal has multiple components) before the NCP suspends the session to service other devices on the line.

Two-channel switch. A feature that allows the 3705 to be attached to two channels through one channel adapter.

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