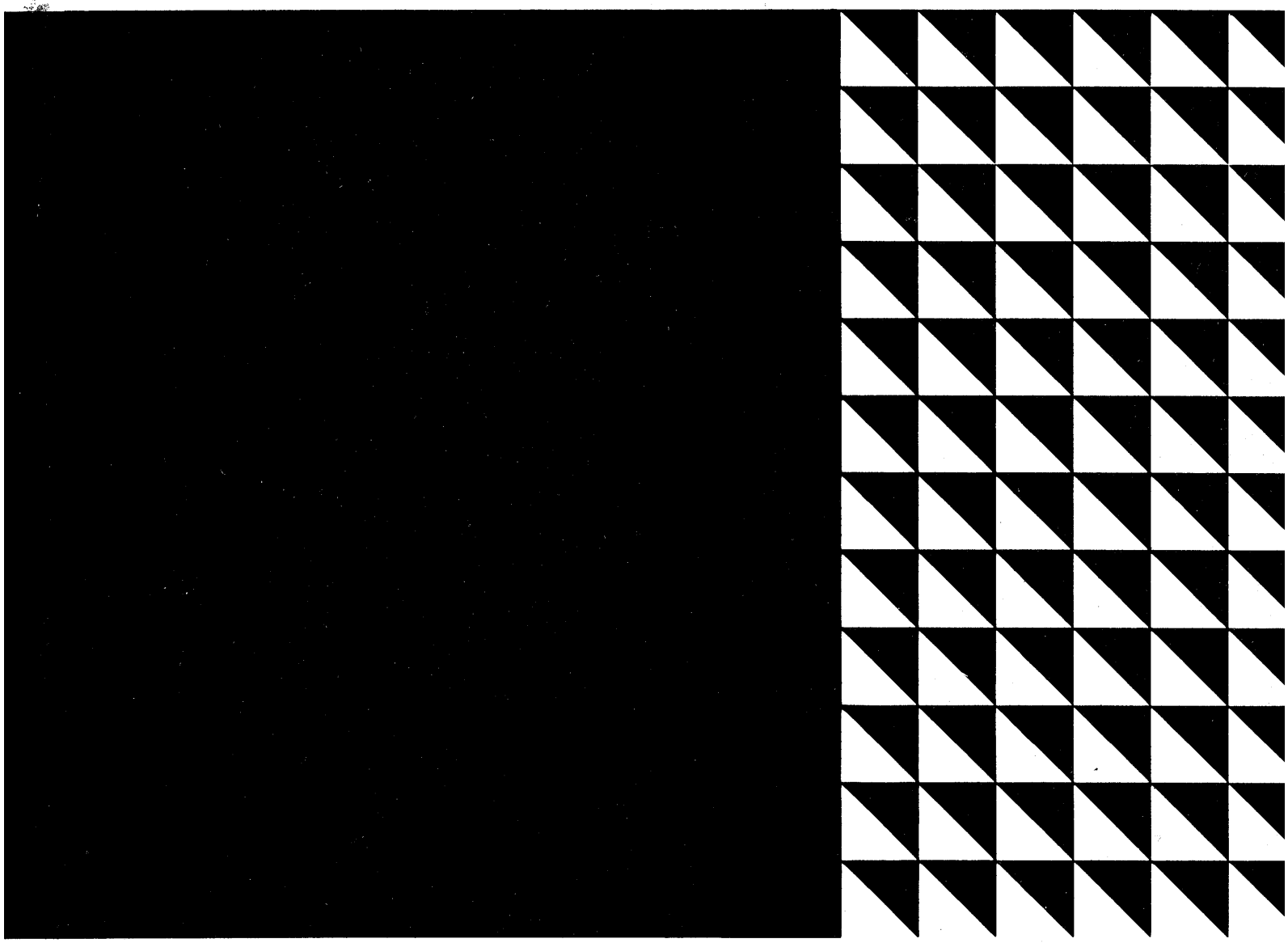

IBM 3704 and 3705 Communications Controllers Hardware

Student Text

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Contents

Preface

This publication is a student text on the IBM 3704 and 3705 Communications Controllers Hardware. References to the program support illustrate how some of the hardware may be used or even required for a specific type of programming.

At the end of each major section is a quiz. The answers to the quiz are given in Appendix A of the text.

If additional information is required, please refer to *Introduction to the IBM 3704 and 3705 Communications Controllers* (GA27-3051), or for more detail refer to *IBM 304 and 3705 Communications Controllers Principles of Operation* (GC30-3004).

Introduction

Objective

Upon completion of this topic the student should be able to identify the terms for the component parts, the relationships of a component to the system, and the general differences between the 3704, 3705-I and 3705-II Communications Controllers.

Introduction

Telecommunication is a growing part of the data processing industry, and telecommunication operations must be flexible to accommodate the increased diversity of products, communications facilities, transmission control units, and other equipment. Furthermore, the extremely time-dependent telecommunication functions put great demands on all the resources of the data processing system. These demands increase as the telecommunication subsystem grows.

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

Data Flow in a Communications Controller

The flow of data between the host system and the terminal should be transparent to the user. The purpose of the communications controller hardware and program support is to provide a path for data flow between the host and terminal. The program which emulates earlier data adapters or transmission control units requires the user to provide code definition, translations, connections for switched networks, polling and addressing characters, etc. Any change to the network usually requires a new generation of the host system to reflect the network change.

The network control program allows the host to communicate with any terminal in EBCDIC, without having to consider special line-control disciplines, terminal codes, polling and addressing characters, error recovery, etc. Any changes to the network should be made directly to the network control program, so that a new generation of the host operating system is not needed. While line-control disciplines, terminal codes, etc. are now transparent at the host and terminal, these elements must be provided in hardware and network control program generation specifications.

Data flow of the emulation program requires a connection to a host subchannel for each line. All of the support to establish that connection, transmit or receive the data, and end the communication must be provided by the host programmer - all in the terminal code. The host program sends the appropriate data to a specific subchannel address. The emulation program receives

the data for that subchannel and by emulation program definition, sends the unchanged data to a specific line interface on a communications scanner. If the host sent a read request, when the data is received from a specific line interface it is directed by the emulation program to the host over that same subchannel. In emulation support, the host programmer assumes responsibility for the network connection, data transmission, error recovery, etc., and changes to the network usually require changes in the host generation and/or application programs.

Data flow in network control program mode is also initiated by the host. All communications are sent from the host over a single channel address, regardless of destination. All communications are in EBCDIC, without any requirement for the host to be aware of line type or device codes.

Each transmission is sent to the communications controller with a prefix identifying the destination as a binary number. The network control program receives this data, identifies the destination by the binary number, and schedules the data to be transmitted to the appropriate terminal. Translation, device codes, line scheduling, error retries and recovery are all handled by the network control program. The data is transmitted to the terminal and a response is sent to the host, if a response was requested. The network control program can receive data from a terminal without a host application request and send the data to the host; such data might be a request from the terminal to communicate with a specific host program. (In previous telecommunication networks the host program had to initiate connections with a terminal.)

Data still must flow from the host channel, but it does so on a single channel, is buffered in the communications controller (not the host), and is scheduled for transmission over an appropriate line with required polling or addressing characters in the required line code. If an error occurs during transmission, the 3704/3705 attempts error recovery without host intervention. A response from a terminal is converted (if required) into EBCDIC and sent to the host with the identifying prefix over the single channel address.

This 'transparent' connection between the host and the terminal must be defined and maintained. The 'transparent' connection should allow for changes that may be made to the network (such as adding or deleting lines and/or terminals) without requiring a new generation of the host system or host applications.

Network Configuration with the Communications Controllers

The 3704 and 3705 controllers, though dissimilar in appearance, serve precisely the same purpose in a telecommunication network. The control programs provide identical capabilities. The essential difference between the two controllers is the size of the networks they can accommodate. Figure A.1 summarizes the differences between the controllers in number of communication lines, maximum line speeds, and available storage capacity. As used throughout this publication the term communication line (or simply line) refers to the path over which information is transmitted from one point in a telecommunication network to another. The path may be any communication facility of the communications common carrier, such as wire, radio, or satellite; or it may be a combination of facilities. SDLC lines are commonly called 'links', and the term link may also be used for a communication facility.

	3704	3705
Maximum number of lines for half-duplex operation	32	352
Maximum line speed (bits per second)	50,000	57,600
Number of communication scanner types available	2	3
Maximum nunber of communication scanners installable	1	4
Number of channel adapter types available	1	4
Maximum number of channel adapters installable	1	2
Range of storage capacity (bytes)	16K-64K	16K-512K
Size of storage increments	16K	32K

Figure A.1 Summary of Differences between 3704 and 3705 Controllers

The control program in the 3704 or 3705 communicates with a telecommunication access method in the CPU to which the controller is connected. This CPU is called the host processor.

A controller may be attached directly to a host processor channel via a channel adapter or may be located many miles distant from the host processor. When all stations are directly connected with a controller attached to the host processor channel the controller is called a 'local' controller. If a local controller has a link attachment to a separate controller which is initially program loaded (IPL) from the local controller, the link attached controller is called a 'remote' controller. Using remote controllers in a telecommunication network allows the controller to be placed nearer the stations it serves, thus reducing the aggregate length of the communication lines. This reduction in line mileage can significantly lessen line charges - a major portion of network cost - even though two controllers and a relatively expensive communication line between them are required.

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

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

In the discussion of a local/remote link, we considered only a single local and single remote controller. However, multiple remote controllers may be connected to the same local controller, each by a separate local/remote communications link. (A remote controller cannot be connected to more than one local controller.)

Two local controllers may be connected by a communications link. Each local controller is channel attached to a host. Communications between

'domains' (host and owned local controllers) occurs over the link between the two local controllers.

The 3705 is designed for either (1) attachment to an IBM System/370 selector, byte-multiplexor, or block-multiplexor channel; (2) communication over a duplex or half-duplex local/remote communication link with a local, channel-attached 3704 or 3705; (3) communication over a duplex or half-duplex local/local communication link to a second domain. The 3704 can be attached to a byte-multiplexor channel or attached as a remote controller.

Program Support For The Controllers

Network Control Program

Much of the increased capability of the controllers is provided by the network control program (NCP), which is executed in the controller. The network control program provides the flexibility necessary to meet increasing telecommunication demands; at the same time it relieves the CPU of much of the telecommunication responsibility.

Support of one to four channels in NCP mode and local/local links for cross domain communication is available in the Advanced Communication Function (ACF) NCP.

Information on SDLC is in the publication *IBM Synchronous Data Link Control General Information.* (GA27-3093). SDLC link control is not covered in this material as a line-control discipline.

Emulation Program

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

The emulation program communicates with access methods running in a System/360 or System/370. Two host CPU's can be attached to a single 3705 with two type 4 channel adapters for concurrent emulation support; a given line is under the control of the first host which enables the line interface.

A feature of the network control program, called the partitioned emulation programming (PEP) extension, allows the program to operate some communication lines in network control program mode while operating others in emulation mode. Lines can be defined for both NCP and EP, and switched from one mode to the other by host operator control. An NCP with PEP can be executed only in a local controller. The program communicates with one or more telecommunication access methods in the System/370 host processor. The emulation portion of PEP can be under the control of one or two CPU's, and emulation can be on one CPU with NCP mode controlled by a second host.

System Support Programs

In addition to the network control and emulation programs, IBM provides system support programs. These programs, which are executed in a central processing unit, generate control programs, load them into controller storage, and dump controller storage.

The IBM 3704 and 3705 Control Program Generation and Utilities Guide and Reference Manual (GC30-3008) provides information on defining network control programs and emulation programs and on using the support programs.

A Compatible Family

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

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

The 3705 is designed for telecommunication installations with medium-to-large networks that require one or more IBM 2701, IBM 2702, IBM 2703 or equivalent control units. In addition, the 3705 offers the smaller user a convenient means of increasing the size of his network. The emulation program and the network control program with PEP allow easy conversion from the 2701, 2702, and 2703 to the 3705. The 3705 supports medium-to-large networks of SDLC links, or mixed networks of SDLC and BSC/SS lines. BSC/SS lines are supported in either emulation or network control program mode.

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

Advantages of the IBM Communications Controllers

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

In the following discussions, the largest of the transmission control units mentioned above (the IBM 2703) is used for comparison to the 3705. Figure

A.2 illustrates some of the advantages that the 3705 with the network control program has over the 2703. These advantages prevail whether the 3705 is a local or a remote controller. The 3704 with the network control program has equivalent advantages.

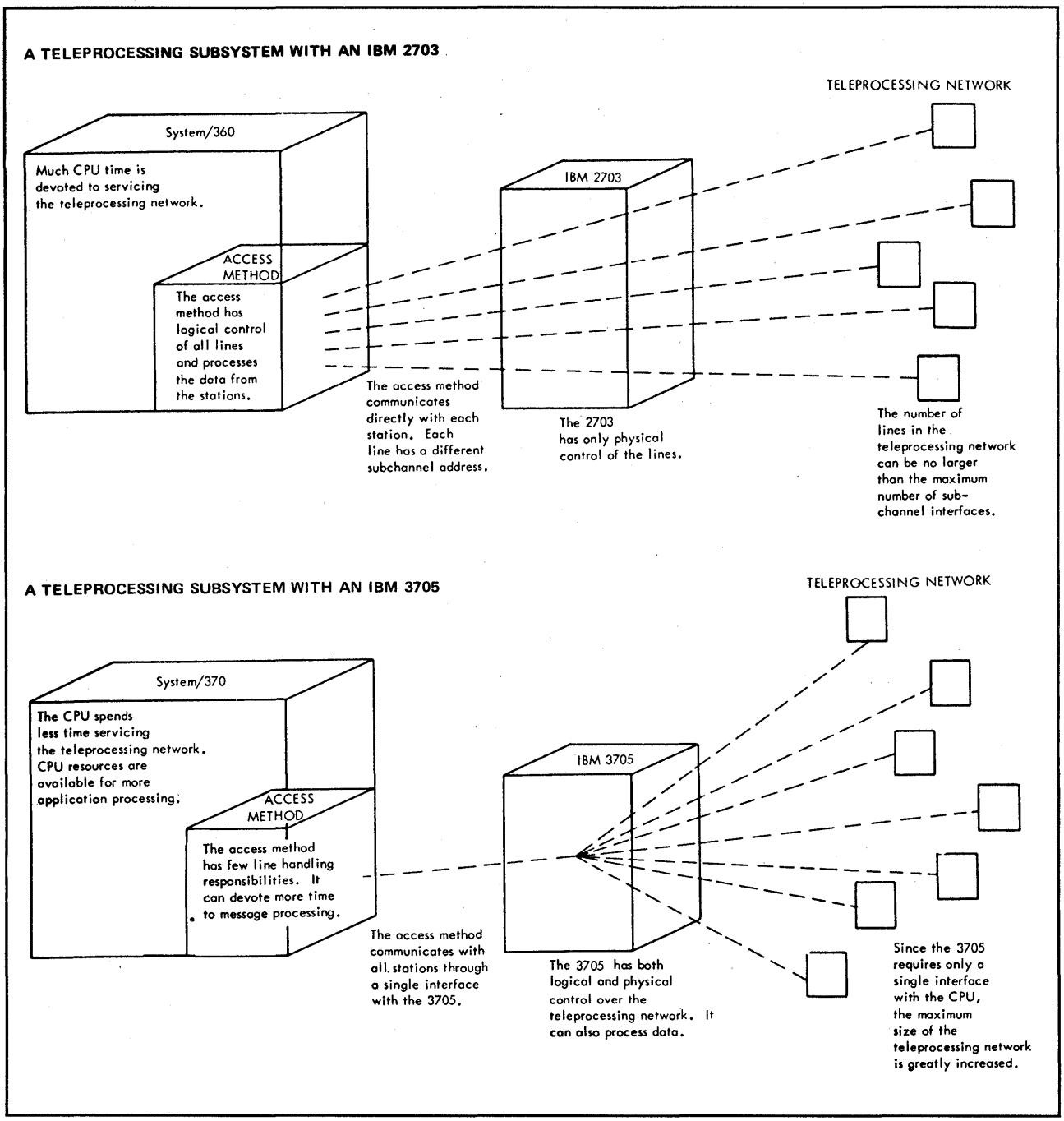

Figure A.2 Advantages of the IBM 3705 over the IBM 2703

Flexible Configurations

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

The 3704 and 3705 can communicate with many types of telecommunication stations using both synchronous and asynchronous line-control disciplines, at line speeds from 45.5 bps to 57,600 bps. The network control program recognizes and translates a variety of transmission codes, including USASCII, EBCDIC, EBCD, BCD, and correspondence code.

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

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

The 3704 and 3705 are connected to a host system channel by a 3704 or 3705 channel adapter. The hardware component in the 3704 and 3705 which interfaces to the lines is called a 'communication scanner'. The 3705 hardware offers additional flexibility in the choice of channel adapters and communication scanners. Depending upon the anticipated throughput and type of system attachment desired, you can choose between four types of channel adapters and three types of communication scanners. Two types of scanners and three types of channel adapters offer high throughput and performance capabilities. The other type of each, which are less expensive but can handle less throughput, are suitable for use with smaller networks. The 3704 is available with the low- and medium-speed scanners of the 3705 and it offers only the low-throughput channel adapter.

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

A high-level macro language is available to describe a network control program tailored to the requirements of your installation. This language gives you control over many of the operating characteristics of the telecommunication subsystem. Some characteristics are controlled by specifying particular values for certain network control program parameters or specific functions to be included in (or excluded from) the program. Other characteristics are controlled indirectly, depending on the network and the options you specify.

Since the scanning mechanism is program-controlled, the controller's scanning hardware need not be rewired for every change in network configuration. When new communication lines are added to the network, the network control program is regenerated to include the new lines and any modifications to the scanning scheme are made automatically.

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

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

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

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

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

The controller is available in different models that allow easy expansion of the telecommunication network. The various models of the 3705 also offer options in the number of channel adapters and communication scanners you can order, in addition to the amount of storage and line-attachment hardware.

Furthermore, the network control program is designed in modules that the user may select according to the requirements of the network. Since no telecommunication subsystem requires all the facilities of the network control program, you can specify through the program generation language just those facilities that your particular installation needs.

Availability

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

For example, the network control program provides error recovery procedures (ERP's) that can recover from many intermittent hardware or transmission

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

Some hardware options also increase the availability of the controllers. For example, three types of channel adapters have a two-channel switch that allows the adapter to be attached to two CPU channels at once. If one channel fails, the channel adapter can be switched manually to the second channel. (This feature cannot be installed on a channel if two channel adapters are installed in the same module and does not provide for simultaneous operation over both channels.) Installing two type 4 channel adapters on a 3705 allows concurrent emulation operation of the network, with the first host to request a specific line obtaining the line. The second host cannot use the same line until it is released by the first host. Two to four type 4 channel adapters installed on a 3705 allows concurrent network control operation of the network.

An option that further increases availability in the larger models of the 3705 is their ability, when executing a network control program to support up to four channel adapters (type 4 channel adapters), two in EP mode, and one to four in NCP mode.

If the channel adapters have the two-channel switch, the 3705 can be attached to as many as four CPUs, making availability even higher. However, only four channel paths at a time can be active for network control program mode. The partitioned emulation program operates over two channel adapters concurrently with network control program mode on the same channel adapters or alternate channel adapters.

The type 3 channel adapter allows the 3705 to be attached to both processing units of a tightly coupled multiprocessor through one channel adapter. The controller appears to each processing unit as the same controller and can be accessed alternately by each processing unit in exactly the same manner. This facility allows the access methods for the controller (TCAM, VTAM, etc.) to run in either CPU, with the path from the 3705 being transparent to the access method. This type of channel adapter can also provide an alternate path when attached to a uniprocessor.

The 3704 can have up to 32 attached communication lines, the 3705 up to 352 lines. The first 3705 communications scanner can have a maximum of 64 lines; each additional scanner can have a maximum of 96 lines. If a scanner fails, only those communication lines attached to it are affected. The rest of the network continues to operate as usual.

Conservation of Host CPU Resources

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

Most of the advantages to the host processor come from the transfer of line-control and buffering functions from the access method to the controller. Much of the line-control information previously maintained in control blocks by the access method is now maintained by the network control program. In

addition, the controller buffers data as it arrives from the station and sends it to the host processor in blocks. Consequently, the access method can allocate buffers after an entire block has arrived from a station, and buffer space in host main storage is no longer tied up while data is being transmitted over the communication lines. Buffer requirements for the access method are therefore reduced, especially when input from the network is high.

The network control program can also take over some of the processing functions, such as date and time insertion, previously assigned to the access method. Including these functions in the network control program saves the host processor both the time and the main storage required by the processing programs. This support is provided by user-coded block handlers which are only for SS and BSC devices.

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

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

Reliability

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

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

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

The controllers have four groups of eight general registers. One group is associated with each of the three lower program levels, and the fourth is

shared by the first two program levels. This feature eliminates much of the overhead involved in saving and restoring register contents when control is being passed from one level to another. Thus, the controllers can devote more time to the network control functions.

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

Error Recovery and Diagnostic Facilities

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

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

The network control program also collects statistics on errors that occur for each line and sends these statistics to the host processor when a given count is reached.

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

Communications Controller Hardware Concepts

3705 Hardware

The 3705 is available in 44 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 G3'. The letter indicates the maximum line-attachment capability; the number indicates the amount of storage. All G-models, for example, can attach up to 256 communication lines for half-duplex operation, and all '3' models with a prefix of E, F, G, or H have storage of 96K. The number of scanners (one to four) are specified as E, F, G, and H; storage is indicated in 32K increments as 1, 2, etc., with the combined letter and number indicating line and storage capacity.

Figure A.3 shows the storage capacity of each 3705 model and the maximum number of lines for half-duplex operation that can be attached to each. (An SDLC line that operates in duplex mode, data transmitted and received

concurrently, counts as two half-duplex lines.) The actual number of lines that the control program can support depends on many factors, such as the line speeds required and the throughput capacity of the control program.

3705-I

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

3705-II

Model	Amount of Monolithic Storage (Bytes)*
E1-F1-G1-H1	32K
F2-F2-G2-H2	64K
E3-F3-G3-H3	96K
E4-F4-G4-H4	128K
E5-F5-G5-H5	160K
E6-F6-G6-H6	192K
E7-F7-G7-H7	224K
E8-F8-G8-H8	256K
J1-K1-L1	320K
J2-K2-L2	384K
J3-K3-L3	448K
J4-K4-L4	512K

	Maximum Number of Half-Duplex Lines
E1 to E8	64
F1 to F8	160
G1 to G8	256
H1 to H8	352

Figure A.3 3705 Storage and Line Capacity

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

An attachment base is a required feature for support of the 3705 scanners. Two types of attachment bases are available: the type 1 attachment base and the type 2 attachment base. The type 1 attachment base provides common controls to the central control unit for both the type 1 scanner and the type 1 channel adapter. The type 2 attachment base provides common controls to the central control unit and line addressing controls for the type 2 and type 3 scanners. One or both of the attachment bases are required, depending on the type of scanner and channel adapter installed in the 3705.

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

A 3705 hardware configuration can have many combinations of components. The combinations vary based upon the type of 3705 (I or II), channel or line attachment (local or remote), the type of channel adapter(s), communication scanners, storage, etc. A brief description of the functions of each segment of hardware follows.

3705 Central Control Unit

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

The 3705 has a two-byte access path with a cycle time of 1.2 us for the 3705 I, and 1.0 us for the 3705 II models A-H, and .9 us for models J-L.

3705 Control Panel

The 3705 control panel contains the switches and indicators necessary for manual control of certain 3705 functions. Some of the functions provided by the control panel are:

1. the ability to store and display information in storage and register
2. the control and indication of power
3. indications of controller status
4. operator/controller communication controls
5. diagnostic controls

In many installations a remote 3705 operates largely unattended. Two useful features are available for a remote 3705: unit protection and remote power-off.

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

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

3705 Storage

The amount of 3705 I storage ranges from 16K to 240K in 32K increments. The amount of 3705 II storage ranges from 16K to 256K in 32K increments, and from 256K in 64K increments to 512K. The 3705 model numbers indicate the amount of storage installed, as previously explained.

3705 Channel Adapters

Four types of channel adapters are available for the 3705. The type 1 CA provides attachment to an IBM System/360 or System/370 byte-multiplexor channel. The type 2, type 3 and type 4 CA's provide attachment to an IBM System/370 selector, byte-multiplexor, or block-multiplexor channel. The type 3 CA enables the 3705 to be attached to System/370 Models 158 and 168 tightly-coupled multiprocessor systems as a symmetrical shared controller and to uniprocessors as a controller with an alternate path capability.

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

Type 1 Channel Adapter

The type 1 CA can handle only a relatively low volume of throughput and requires intervention from the 3705 control program for each data transfer burst. It is adequate, however, for many small networks and is less expensive than the other channel adapters. The type 1 channel adapter transfers data in four byte bursts, with program intervention required after each transfer. The type 1 CA provides emulation, NCP, or PEP support to a single host. It also can provide emulation support to one host while a second CA provides NCP support to the first or a second host. If a second CA is installed with a type 1 CA it must be either a type 2 or type 3. A two-channel switch allows connection to two host systems.

Type 2 Channel Adapter

The type 2 CA transfers data by cycle steal, requires less intervention from the 3705 control program than the type 1 CA, and can handle a larger volume of throughput. The type 2 channel adapter requires program intervention at the end of each buffer or at the end of message. The type 2 CA supports NCP mode only; however, it can be installed on the same 3705 with a second CA of the same or different type. A two-channel switch allows connection to two host systems.

Type 3 Channel Adapter

The type 3 CA provides the same capabilities as the type 2 CA. The type 3 CA provides a dual interface to tightly coupled multiprocessors allowing a single NCP to be addressed from either processor. The type 3 CA can be attached to two CPU channels. These two channel interfaces can be simultaneously enabled, and alternate (though not simultaneous) operation over the two interfaces is permitted. When a channel input or output operation over one channel interface is being executed, an attempt to initiate operation by the second channel (attached through the type 3 CA's second interface) causes a 'busy' status to be presented over that interface. Having given a 'busy' status, the adapter generates an asynchronous Device End (DE) when the operation causing the busy state has been completed on the opposite channel interface.

The type 3 CA can be enabled to either interface or to both at the same time. Enabling and disabling of the channel interfaces are controlled by manual switches located on the 3705 control panel. A pair of enable/disable switches exists for each type 3 CA (one for each channel interface). The type 3 CA supports NCP mode only, however it can be installed on the same 3705 with a second CA of the same or different type. The two-channel switch is not available on the type 3 CA.

Type 4 Channel Adapter

The type 4 channel adapter has two modes of operation. Programming can initialize the channel to operate either in cycle steal mode or data transfers of four, eight, sixteen, or thirty two bytes. The cycle steal mode is only supported by NCP advanced communications function (ACF). Emulation programming and NCP release 5 uses a four-byte data transfer.

The type 4 channel adapter operates in cycle steal mode for the length of an NCP buffer. Up to four type 4 channel adapters can operate concurrently in NCP mode.

Up to two type 4 channel adapters can operate concurrently in EP or PEP mode. Each host may use a portion of the EP lines; the first host which sends an enable to a line obtains the line until it is disabled. Emulation mode lines to a type 3 scanner require a type 4 channel adapter.

Two type 4 channel adapters can be installed in the 3705 I. Up to four type 4 channel adapters can be installed in the 3705 II. When a type 2 or type 3 is installed with a type 4 only two channel adapters are allowed.

A type 4 channel adapter may have a two-channel switch, allowing attachment to two host systems.

Attachment of Multiple Channel Adapters

Up to four channel adapters can be installed in the 3705. The models combinations available are as follows:

1. One CA of any type; only one type 1 CA is allowed per 3705.
2. One type 1 CA with one type 2 or type 3 CA.
3. Two type 2 CA's, two type 3 CA's, or one type 2 CA and one type 3 CA.

4. One type 4 CA with one type 2 or one type 3 CA.
5. One or two type 4 CA's on the 3705 I; one, two, three or four type 4 CA's on the 3705 II.

The multiple CA's can be attached to the same or different host systems. Two type 4 CA's may be operational at the same time in emulation mode, and up to four type 4 CA's may be operational in NCP mode.

If multiple type 4 channel adapters are installed, one or two channel adapters can be installed in each of the first frame and/or second frame. If the remote program loader (RPL) is installed, the RPL takes the first channel position in the first frame. If two channel adapters are installed in the same frame (or RPL and CA), the two-channel switch feature is not available and the second channel adapter eliminates the third line interface base (LIB) position on the scanner of that frame.

3705 Network Control Program Support for the Channel Adapters

The network control program (NCP) can support all channel types. However, a network control program can contain the NCP code for support of one CA type only (type 2 and 3 CA are identical). Multiple concurrent NCP support is only available with the Advanced Communications Function. If the 3705 is equipped with multiple type 2, type 3, or type 4 channel adapters with NCP 5 or without Advanced Communications Function, the nonsupported channel adapter should be disabled when operating in network control mode.

Support of a type 1 or type 4 channel adapter for emulation mode and a type 1, type 2, type 3 or type 4 channel adapter for network control program mode is covered the section Partitioned Emulation Support for the Channel Adapters which follows.

3705 Emulation Program Support for the Channel Adapters

The emulation program can operate only with the type 1 or 4 channel adapters. Therefore, when the 3705 with a type 2 or 3 channel adapter is operating with the standalone version of the emulation program, the type 2 CA or type 3 CA should be disabled.

If two type 4 channel adapters are available and connected to two host systems, both hosts can share a single 3705 for emulation mode lines. Either host has access to any emulation line. The first host which initiates line activity (enable) obtains the line. When the line is released (disable), the alternate host can initiate a connection on that same line.

Partitioned Emulation Support for the Channel Adapters

A network control program with the PEP extension can contain the code to support cycle steal channel adapter and emulation mode channel adapter. (Operation in emulation mode is possible only with the type 1 or 4 channel adapter.) If the the 3705 is equipped with a type 1 or type 4 CA and a type 2 or type 3 CA, the type 1 or type 4 adapter handles data interchanges for communication lines in emulation mode, and the type 2 or type 3 adapter handles data interchanges for the lines in network control mode. A type 1 or type 4 channel adapter can support both emulation and network control mode concurrently without a type 2 or type 3 CA. If multiple type 4 channel

adapters are installed, one or two may operate in EP mode concurrently with one to four in NCP mode.

3705 Two-Channel Switch Feature

The type 1, type 2, and type 4 channel adapters offer an optional two-channel switch which allows the 3705 to be attached to two channels through one channel adapter. (The channels can be attached to the same CPU or two different CPU's.) Only one of the channels, however, 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.

The two-channel switch is not available if (1) two channel adapters are installed in the same frame or (2) if a remote program loader (RPL) is installed in the same frame.

Remote Program Loader

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

A 3705 I equipped with a remote program loader cannot have a channel adapter. The 3705 II with Advanced Communications Function may have up to three channel adapters and the remote program loader. This allows a 3705 II to be channel attached on one to three host systems and, if required, available to be IPL'ed as a remote. To IPL a 3705 as a remote, all channel adapters must be disabled.

3705 Communication Scanners

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

The normal transmission on communication links is serial by bit. The purpose of the communications scanners is to receive or transmit bits on the link. The communications scanner may also receive bits serially from the line to build characters and deserialize characters for bit transmission on the line. The scanner may also provide character transfer into or from program buffers by cycle steal. The level of control is divided between programming and hardware. Depending upon the amount of hardware support, the programming may provide or receive from the hardware a single bit, a single byte, or an entire program buffer.

There are three communication scanners available on the 3705. The type 1 communications scanner requires a program interrupt for each bit sent or received on a line. The type 2 scanner requires program service for each byte sent or received on a line. The type 3 scanner uses cycle steal and requires interrupts only at the end of a buffer or end of message.

Up to four scanners can be installed per 3705. The number and mix of scanner types and lines per scanner are listed under each scanner type.

Type 1 Scanner

The type 1 scanner requires a program interrupt on each bit sent or received. The program assembles and disassembles characters. The maximum speed of line for a one-line type 1 scanner is 7200 bps. Sixty four lines of less than 300 bps each are the maximum line configuration for a type 1 scanner. One type 1 scanner is the maximum per 3705. Type 1 scanners cannot be installed with any other type of scanners.

Type 2 Scanner

The type 2 scanner requires program intervention for each character sent or received. A maximum of two 50,000 bps lines is available on the 3705. The first of four possible type 2 scanners can have up to 64 lines; each additional type 2 scanner may have up to 96 lines for a total of 352 lines, with a maximum speed of 600 bps per line.

Type 2 scanners may be installed with type 3 scanners in any combination.

Type 3 Scanner

The type 3 scanner is a cycle-steal scanner requiring program intervention at the end of each buffer or end of message. The type 3 scanner supports BSC or SDLC, not SS. BSC is supported for either ASCII or EBCDIC. The first scanner position supports up to 48 lines; the other three scanner positions can support up to 64 lines each. Eight 57,600 bps lines is the maximum speed of type 3 scanner support. If emulation support is defined for this type of scanner, the type 4 channel adapter is required; type 1 CA is not supported with the type 3 CS.

Line Interface Bases and Line Sets

Communication lines are attached to the 3704 and 3705 through line interface bases (LIB's). Several LIB types are available to handle requirements for different types of line terminations. Depending upon the type of line termination, as many as sixteen communication lines can be attached through one LIB. The type 1 scanner supports up to four LIB's. The type 2 scanner supports up to four LIB's in the first scanner position and up to six LIB's in nonfirst scanner positions. The type 3 scanner supports up to three LIB' in the first scanner position and up to four LIB's in nonfirst scanner position. The third LIB position of a scanner cannot be used if two channel adapters or a channel adapter and remote program loader (RPL) are installed in the same frame.

Communication lines are attached to LIB's through line sets. A single line set may provide the interface for one or two communication lines, depending upon the type of interface.

3705 Cycle Utilization Counter

The cycle utilization counter may be installed in the 3705 II. The cycle utilization counter accumulates statistical data on 3705 II cycle utilization for access by the user. The data includes cycles taken for instruction execution,

cycle steal operations and maintenance. From this data ACF/NCP/VS Release 2 can provide information on the percentage of available cycles utilized.

3705 Extended Environment Feature (Remote 3705 Only)

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

3705 Internal Air-circulation Features (Remote 3705 Only)

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

3704 Hardware

The 3704 consists of a single module that contains the central control unit; the control panel; storage ranging from 16K bytes to 64K bytes in 16K increments; a communication scanner; the line-attachment hardware necessary to connect as many as 32 communication lines for half-duplex operation; and either (1) one type 1 channel adapter for attachment to an IBM System/360 or System/370 channel, or (2) a remote program loader.

The 3704 does not require an attachment base and therefore is not specified in the following material.

3704 Central Control Unit

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

The 3704 has a one-byte access path with a cycle time of .6 us.

3704 Control Panel

The 3704 control panel contains the switches and indicators necessary for manual control of certain 3704 functions. Some of the functions provided by the control panel are:

1. the ability to store and display information in the 3704 storage and register.
2. the power control and indications.
3. indicators of controller status.
4. operator/control communication controls.

5. diagnostic controls.

Like the 3705, the unit protection lock switch and remote power-off features are available for remote 3704 controllers.

3704 Storage

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

The amount of storage in the 3704 is designated by 3704 models. Figure A.4 shows the model names and amount of storage in each.

3704

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

Figure A.4 Storage and Line Capacity

3704 Channel Adapter (Local 3704 Only)

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

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

3704 Remote Program Loader (Remote 3704 Only)

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

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

3704 Communications Scanners

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

Type 1 Scanner

The type 1 scanner interrupts the control program for each bit that arrives or leaves over a communication line. The program assembles and disassembles characters. The type 1 scanner can have up to 32 lines. A limit of one line of 4800 bps is the maximum for a type 1 scanner.

Type 2 Scanner

The type 2 scanner interrupts the program only when an entire character has been received from or transmitted onto the communication line. The scanner hardware assembles and disassembles characters. A maximum of 26 lines is available with the type 2 scanner. The maximum line speed is two 50,000 bps lines on a type 2 scanner.

Line Interface Bases and Line Sets

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

Communication lines are attached to a LIB through line sets. A single line set may provide the interface for one or two communication lines, depending upon the type of interface.

3704 Extended Environment Feature (Remote 3704 Only)

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

IBM 3704 and 3705 Hardware Introduction Review

The 3705 allows for more lines at higher speeds and more storage than the 3704. The 3704 and 3705 can be attached locally to a host channel or attached remotely by communication lines to a remote communications controller. The 3705 II can be attached locally via one, two, or three channel adapters and have a remote program loader. If the 3705 II is IPLed via the remote program loader the channel adapters must be disabled. Each of the controllers is individually configured to meet the needs of a specific network, so a knowledge of the components in necessary to select the appropriate options properly.

IBM 3704 and 3705 Hardware Introduction Quiz

In the following quiz you are testing yourself. You should try to answer the questions without referring to the reading assignment materials or the answers in Appendix A.

True or false:

1. The 3704 and 3705 communications controllers do not perform the same functions.
2. The 3705 remote communications controller never has a channel adapter.
3. The 3704 maximum transmission rate for one line is less than the 3705 one-line maximum rate.

Completion:

4. The maximum storage for a 3704 is _____.
5. The maximum storage for a 3705 is _____.
6. The maximum number of lines on a 3704 is _____.
7. The maximum number of lines on a 3705 is _____.

Criterion:

If you missed more than two questions or had to refer to the text for more than two answers, you should review the reading assignment.

IBM 3704 and 3705 Central Control Units

Objective

Upon completion of this topic the student should be able to identify the features of the communications control unit, identify a given storage size by model numbers, and select a type of channel adapter and scanner according to a defined configuration requirement list.

System Structure

This section describes the registers, interrupt schemes, and program levels used in the 3704 and 3705. The user needs a thorough understanding of these facilities in order to program the controller efficiently. A general knowledge of the facilities is helpful in understanding the programming and may be necessary in analyzing programming problems. Except for extended addressing, this material applies to both the 3704 and 3705 controllers. The extended addressing feature is not available in the 3704.

Registers

The controller has two types of registers: general and external. These registers vary in size and location according to the way they are used. They can range from one bit to twenty bits. The following paragraphs briefly describe the types, size, and usage of the registers.

General Registers

Thirty-two general registers are available in the controller for program use. These registers are located in a local storage array so as not to occupy usable storage locations. The basic size of each register is one halfword (16 bits). The bits are designated from left to right as byte 0, bits 0-7 and byte 1, bits 0-7. In a 3705 with 256K or less storage with extended addressing, each register contains 18 information bits. The 18 information bits are designated from left to right as byte X, bits 6-7; byte 0, bits 0-7; and byte 1, bits 0-7. In a 3705 with more than 256K storage with extended addressing, each register contains 20 information bits. The 20 information bits are designated from left to right as byte X, bits 4-7; byte 0, bits 0-7; and byte 1, bits 0-7. Without extended addressing, byte X is not present and any reference to it is ignored.

As shown in Figure B.1, the 32 general registers are divided into four groups of eight registers each. Each group is assigned to a specific program level, except for group 0, which is shared by program levels 1 and 2. These multiple register groups allow the control program at one level to be interrupted by another level without the need to save registers. The general registers are numbered 0-7 within each group. Only one group of general registers is active at a time -- the group associated with the active program. The registers within the currently active group are directly addressable with program instructions. The control program can gain access to the general registers in a nonactive group by specifying them as external registers in input and output instructions. The X byte illustrates storage of greater than 64K but not more than 256K.

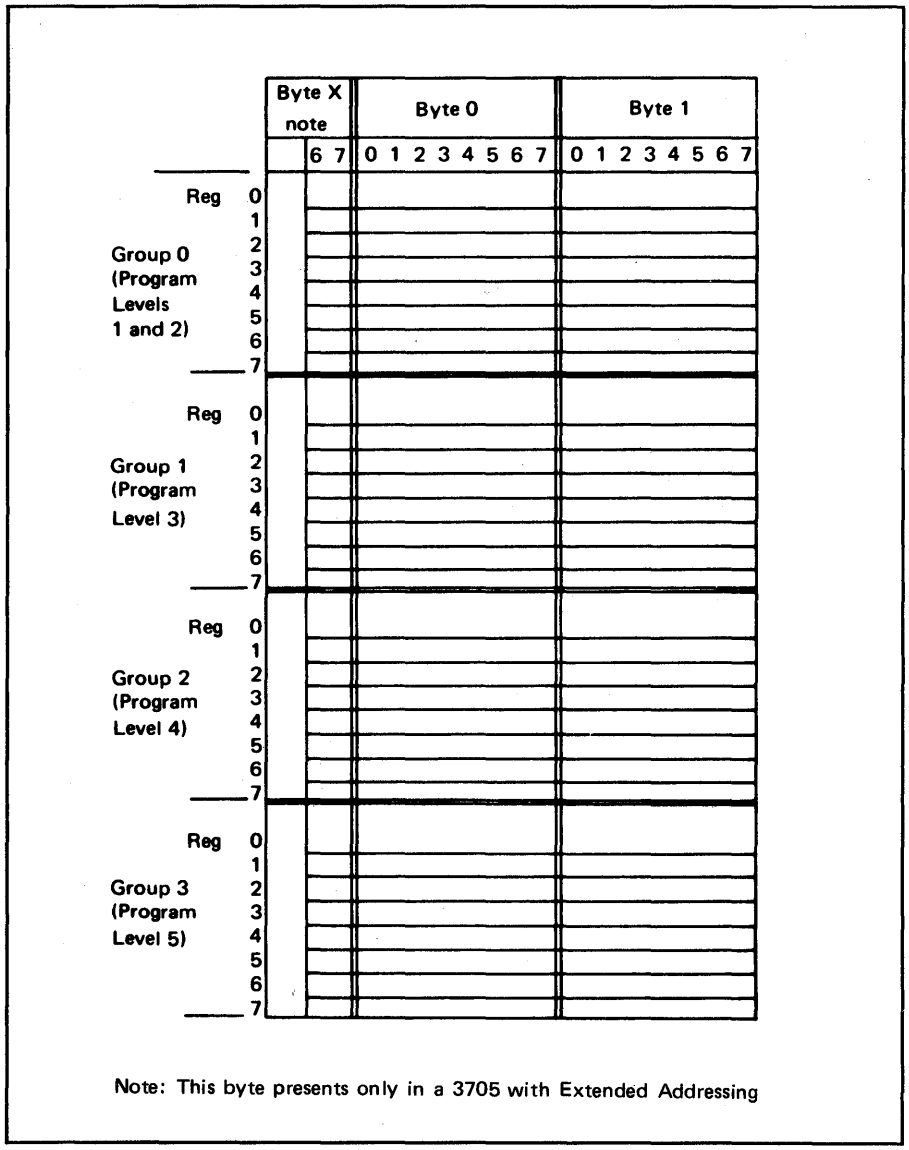

Figure B.1 Function of the Program Levels in the Network Control Program

Instruction Address Register

General register 0 in each group is the instruction address register (IAR). This register contains the address of the next instruction to be executed for the associated program level. Before the current instruction is executed, register 0 of the active group is always incremented to point to the next sequential instruction. In most cases, the next halfword is the next instruction to be executed. Sometimes, however, the contents of the instruction address register are changed as the result of the instruction being executed. Execution of a branch instruction, for example, can cause the IAR to be loaded with a storage address other than the one immediately following the current instruction. The instruction to be branched to is identified by the address in register 0; the address of the branch instruction is saved at hexadecimal address 7BC.

External Registers

Each functional unit of the communications controller (central control unit, communication scanner, channel adapter) has a number of hardware registers that are used to store the information required for communication between the control program and hardware circuits. These registers are called 'external' registers.

Many of the external registers contain information pertinent to the operation of the hardware and/or the program. By using an input instruction, the control program can load the contents of an external register into a general register, where the program can operate on the data. Output instructions load an external register with the contents of the general register specified in the instruction.

External registers are identified by a hexadecimal value of 00 to FF. Each two-hexadecimal value is associated with an external register. Each external register is associated with some hardware component, such as a channel adapter, scanner, panel, or general register of another program level. To obtain data from a communications scanner, it is necessary to read from the scanner external register with an INPUT instruction which identifies the external register of the scanner and a general register to receive the data. An OUTPUT instruction to the scanner identifies the general register which contains the data to be sent, and the external register which is to receive the data sent from the general register.

Instruction Set

The 3704 and 3705 instruction set has a format similar to the System/370 assembler instructions. The operation code defines the type of instruction; the operands are either registers, base-displacement operands, immediate data, or external register references. The instructions are assembled by a 3704/3705 assembler which executes in the host system. The 3704/3705 assembler allows for symbolic coding of the instruction operands. In addition to the assembling of the instructions, the assembler recognizes define constant (DC) and define storage (DS) instructions with operands for binary, character, halfword, fullword, hexadecimal, and address constants. Assembler commands (such as PRINT, DSECT, etc.) and macro statements are almost identical to those in the System/370 assemblers.

You code at the instruction level only if you are writing your own control program or writing user block-handler code for the network control program. The emulation program and network control programs are generated from macros and do not require any user assembler coding.

The communications controller contains 51 executable instructions that can be used to tailor a control program to meet the specific needs of the teleprocessing system. The instruction set provides the greatest possible program flexibility within a minimum amount of storage.

The instruction length can be either one or two halfwords. All instructions must be located in storage on integral halfword boundaries.

Instruction Operation Codes

The eight basic instruction formats are denoted by the format codes RR, RS, RT, RA, RSA, RE, RI and EXIT. The format codes express in general terms the operation to be performed. RR denotes a register-to-register operation; RS, a register-storage operation; RSA, a register-to-storage-with-addition operation; RT, a branch operation; RA, a register-to-immediate address operation; RE, a register-to-external register operation; RI, a register-to-immediate operand operation; and EXIT, a program level exit operation.

To help describe the execution of instructions, operands are designated as either first or second operands. For RR format instructions, the first and second operands are denoted by the number following the name of the field (for example R1, R2).

Instruction Operand Fields

Instruction operands are in four classes:

1. immediate operands in the instructions themselves
2. operands in external registers
3. operands in the active group of general registers
4. explicitly addressed operands in storage

The instructions allow storage fields to be placed into general registers or moved from general registers into storage fields. There are no storage-to-storage instructions. The instruction set is designed to allow bit- and byte-level processing. Addition and subtraction in binary is supported, but multiplication and division (except by routines) is not supported.

The 3704 and 3705 are bit- and byte-oriented machines. The instructions provide a register reference to select a specific byte or a bit within a byte. An operand reference to select byte 0 of register 3 is coded 3(0). To select bit 7 of byte 1, register 5, the operand is coded as 5(1,7).

Many of the instructions set one of two condition latches to indicate a high/low/equal, minus/zero/plus, or bit on/off condition. These latches can be tested, allowing branching based upon the condition latches. A condition latch is a hardware latch that may be set or reset by instruction execution. Each of the five program levels has its own set of two condition latches. These condition latches are designated as C and Z. The latches may be tested by branch instructions, but they are never reset as a result of a branch. Since there is a separate set of C and Z latches for each of the five program levels, the state of the condition latches used by an interrupted program is not affected by other interrupted programs.

If additional detail is desired on coding 3704 or 3705 instructions, extended mnemonics, or NCP internal macros, refer to *IBM 3704 and 3705 NCP Instructions and Supervisor Macros* (SR20-4512).

Program Levels

The controller hardware has five operational program levels. Each program level operates like a subroutine and is responsible for particular phases of the system operation. Figure B.2 shows:

1. the program levels in order of priority
2. the interrupt requests causing the entry
3. the general register group associated with each level

Program level 1 has the highest priority, program level 5 the lowest. Program levels 1, 2, 3, and 4 (referred to as interrupt program levels) provide the program interface between the hardware functional units and program level 5 (referred to as the background program level). The following is a brief description of each of the five program levels.

Background Program Level 5

This level is the lowest priority level which normally is active when none of the other four levels requires program cycles. Functions performed by this level normally include:

1. line management (host command interpretation)
2. data and message handling
3. control command decoding and execution

Level 5 cannot interrupt another program level.

Interrupt Program Level 4

The functions performed by this level normally include:

1. overall management of the system resources
2. buffer management
3. queue manipulation
4. the dispatching of program level 5 tasks

Certain program-controlled interrupt requests and the supervisor call request (generated when the EXIT instruction is executed at level 5) are assigned to this program level.

Level	Operations Performed	Starting Address	Means of Getting Control
5	• Interpretation of commands from host. • Control of polling and addressing. • Decoding and execution of system examination and modification requests. • Data handling functions. • Block handling functions. • Initiation and termination of line I/O. • Panel functions. • Boundary network node (BNN) processing. • Physical services functions. • Function management.	N/A	• Default from other four levels.
4*	• Buffer management. • Queue management. • Task dispatching. • Supervisory services.	X'0180'	• PCI. • SVC.
3	• Interval timer functions. • Handling of panel functions. • Channel adapter management. • Communication processing deffered from level 2. • Intermediate network node (INN) processing.	X'0100'	• PCI. • Type 1, type 2, type 3 and type 4 CA. • Interval timer. • Panel INTERRUPT push button.
2	• Buffer service for communication lines. • Character service for communication lines. • Bit service for communication lines.	X'0080'	• Type 1, type 2, and type 3 scanner.
1	• Machine check handling. • Program check handling. • Adapter check handling. • IPL procedure. • Address trace facilities.	X'0010'	• IPL. • Address exception check. • Type 1, type 2, type 3 and type 4 CA checks. • Type 1, type 2, and type 3 scanner checks. • Address compare. • Protection check. • Input/output check.
x	• Detection of branch to zero.	X'0000'	• Branch to zero.

* Level 4 operations can also be performed at levels 1 and 3.

Figure B.2 Function of the Program Levels in the Network Control Program.

Interrupt Program Level 3

Level 3 should be used for most of the host processor/channel adapter interaction. This level handles interrupt requests from the channel adapter(s), the interval timer, the control panel Interrupt push button, and the communi-

cation processing that can be deferred from level 2. In addition to hardware interrupts, level 3 can be called by program-controlled interrupts (PCI) for initiating data transfers to the channel or lines. Level 3 interrupts are less critically time-dependent than those assigned to program level 2.

Interrupt Program Level 2

Because of its high priority, this level services only interrupts from the communication lines for character or bit service. The control program can request a level 2 interrupt, but for the most part, level 2 is entirely hardware-interrupt driven. Normal operational interrupt requests from the communication scanner include:

1. type 1 scanner bit-service interrupts
2. type 1 scanner character-service interrupts
3. type 2 scanner character-service interrupts
4. type 3 scanner buffer-service interrupts

Only critically time-dependent processing should be done at this level.

Interrupt Program Level 1

This level is the highest priority program level. Level 1 can be masked for channel adapter and scanner checks only when the central control unit is in the test mode. A level 1 interrupt which is invoked mainly to service 'trouble' indications, is hardware-interrupt driven. Conditions that cause a level 1 request include all critical check conditions, such as:

1. program checks
2. addressing exceptions
3. central control units (CCU) checks
4. scanner and channel adapter checks

Initial program load (IPL) procedures and address compare interrupts are also handled at this level.

Because the same group of general registers is used for both level 1 and level 2, the level 1 program saves the group 0 registers. A STORE instruction with register 0 specified (IAR) is the first instruction executed in program level 1. This instruction saves the register for use in program level 2, when level 1 completes. All other registers of group 0 are also saved.

Interrupts

The communications controller operates in response to requests from either the control program or the hardware. Since these requests may have varying degrees of urgency, a priority system is used. Each program, CCU, and adapter request in assigned a particular priority level. A request for use of the controller by the control program or hardware functions is called an 'interrupt request'.

Each interrupt request is assigned to a program level. These program levels, numbered from one to five, determine the priority structure. Program level 1

has the highest priority, and the priority level decreases from level 1 to level 5.

The machine priority controls determine when a interrupt can occur. If the interrupt request is to be allowed, the change from the active program level to the interrupting program level takes place immediately after completion of the instruction currently being executed. If several interrupt requests having different priorities are present at the same time, the one with the highest priority obtains use of the controller. When an interrupt request is granted use of the controller, that use can be interrupted by another request having a higher priority.

When an interrupt occurs, instruction execution at the lower priority program level is suspended until instruction execution is completed at the higher priority level. An interrupt to a specific program level prevents future interrupt requests, assigned either to that level or to lower priority program levels, from causing another interrupt until the servicing of the first interrupt is complete.

The controller does not allow a particular interrupt if any of the following conditions exist:

1. a higher priority request is present
2. the program level to be interrupted is already entered ('interrupt entered' latch is on)
3. the interrupt request or the program level to be interrupted is masked (interrupts to that level are not allowed)
4. a type 3 scanner cycle-steal request exists
5. a type 2 or type 3 channel adapter cycle-steal request exists

At the time an interrupt is honored, the 'interrupt entered' latch for that program level is turned on. The 'interrupt entered' latch is a hardware latch that signals the controller that the associated program level has been entered. As long as this latch is on, no other interrupt requests to that level are honored. The latch prohibits interrupts that could destroy necessary information. The 'interrupt entered' latch is not turned off when its associated program level is interrupted by a higher priority level. The latch is turned off only by an EXIT instruction or by a reset condition to the controller.

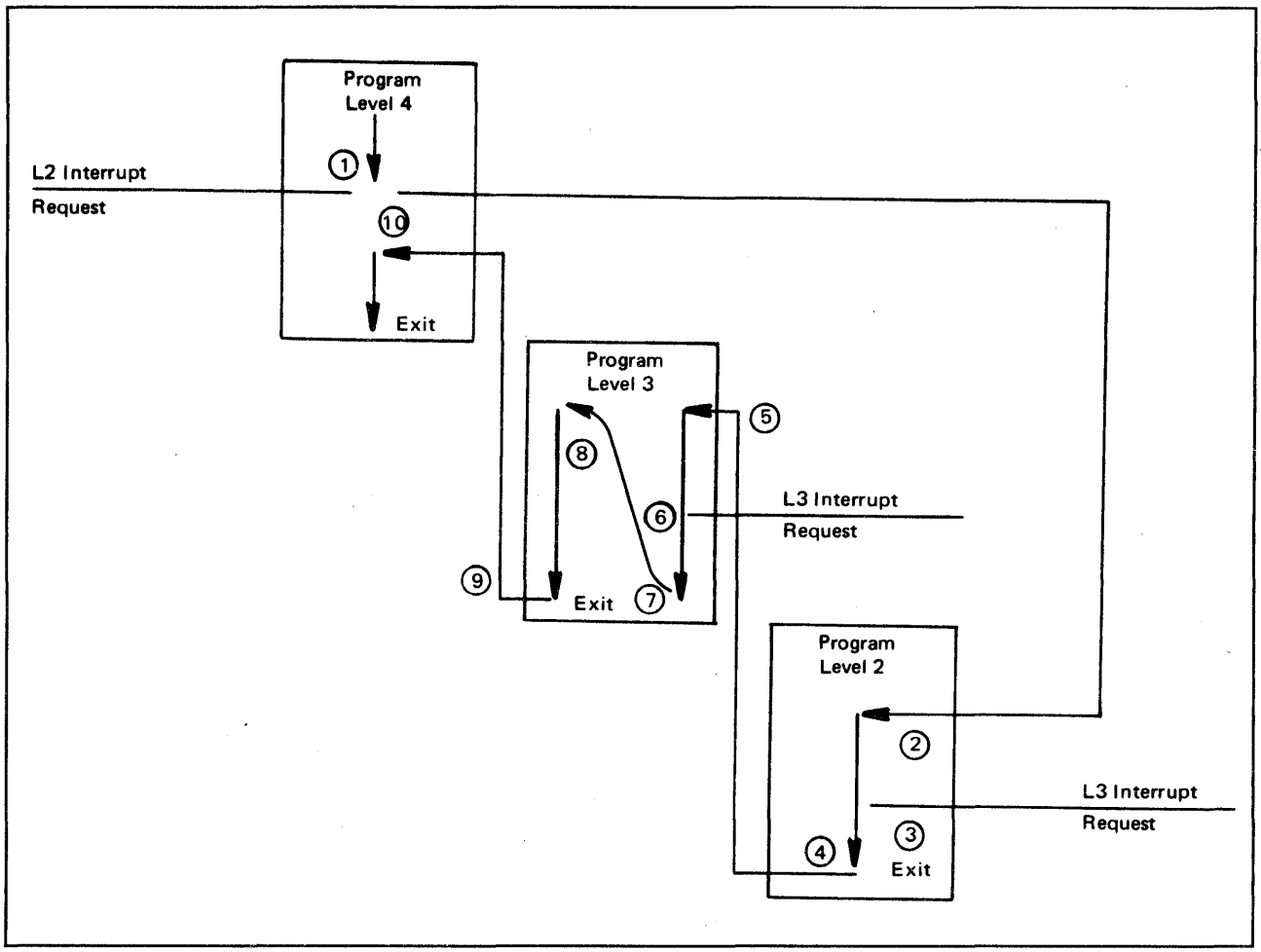

Figure B.3 Interrupt Priority Example

For an example of the interrupt facility, refer to figure B.3. The program at level 4 is being executed, and a level 2 interrupt request occurs (1). The controller hardware forces a branch to the starting address of program level 2 (2), and the program at that level begins servicing the interrupt. A level 3 interrupt request occurs (3) but is not honored because program level 2 has a higher priority. When the level 2 interrupt has been serviced, the program executes an EXIT instruction (4). The controller now allows the higher priority interrupt pending to be serviced. In this example, control is passed to level 3 at its starting address (5). If, before the level 3 interrupt has been completely serviced, another level 3 interrupt request occurs (6), no action is taken because the level 3 'interrupt entered' latch is on. However, as soon as program level 3 executes an EXIT instruction (7), signaling the completion of processing and turning off its 'interrupt entered' latch, the controller can honor the second level 3 interrupt request and return control to the starting address of program level 3 (8). When servicing of the latest interrupt is complete and the EXIT instruction is executed (9), control is again passed to the highest priority level that is able to execute. In this case program level 4 is the highest priority level requiring service (10), so control is returned to level 4 at the instruction following the point of interruption.

At times it may be desirable not to interrupt a particular operation by a higher priority request. For such cases, a mask can be set to prevent interrupts to a particular program level.

When an interrupt occurs, instruction execution at that level begins with the instruction located at the starting address of that level. The starting address of each interrupt level is a permanently assigned storage location. The instructions beginning at these fixed locations must direct the control program to the correct routines to handle a particular interrupt. The remainder of the instructions for a particular program level need not be located in any specific storage area. In addition, some routines may be used by more than one program level. However, in that case, the execution of that routine will be at the priority level of the currently active program level.

The starting addresses for the four program levels that can cause an interrupt are:

```
Program level 1  X'0010'
Program level 2  X'0080'
Program Level 3  X'0100'
Program level 4  X'0180'
```

When a program level has completed its interrupt servicing, it must execute an EXIT instruction. The EXIT instruction causes the 'interrupt entered' latch for that level to be reset and allows control to be passed to the higher priority program level requiring service.

When the EXIT instruction is executed at program level 5, a supervisor call interrupt request for level 4 (SVC L4) is set. This is the only case in which program level 5 can generate an interrupt request. At level 5 the EXIT instruction is followed by a halfword value which specifies the SVC value. This value is used by level 4 to determine the type of request. Level 5 requests supervisor services by SVC requests.

Storage Sizes

Storage sizes are based upon the 3704, 3705 I, and 3705 II. Storage sizes have a basic minimum of either 16k or 32k, and increments of either 16K or 32K to a maximum storage size based upon one of the three models. The memory size is identified by a model number, which is given for each category as follows:

3704

The basic storage of the 3704 is 16K, expanded in increments of 16K to a maximum of 64K. The model numbers of A1, A2, A3, and A4 correspond to the quantity of storage.

3705 I

The basic storage of the 3705 is 16K, expanded in increments of 32K to a maximum of 240K. The model numbers of the 3705 I identify the one to four modules by the letters A through D, with each module having a capacity for 0K, 16K (first storage unit only), or 32K. After the basic 16K of storage, 32K increments can be added not to exceed two storage units per module. The number which follows the A to D indicates the amount of storage installed. Therefore, model A1 is a single module of 16K; A2 is a single module of 48K; A3 is not valid as only two units of storage can be in a module. The

D module can have storage from 1 to 8, 16K to 240K. The module number also indicates the number of scanners (one to four) which may be installed.

3705 II

The 3705 II has a minimum storage of 32K, expanded in increments of 32K up to 256K, and increments of 64K over 256K to 512K. Storage of 256K or less are indicated by of the 3705 II identified by letters E, F, G, and H. All storage of 32K to 256K is in module 1, with no storage in modules 2, 3 and 4. Therefore, each of the modules may specify one to eight storage sizes. Storage over 256K is identified by letters J, K, and L with storage over 256K in increments of 64K in the second module. A separate module is required for each installed scanner, and four scanners require four modules, regardless of the 32K to 512K of storage.

Storage Addressing

Byte locations in storage are consecutively numbered starting with zero; each number is considered the address of the corresponding byte. A group of bytes in storage is addressed by the high-order byte of the group. The number of bytes in the group is either implied or explicitly defined by the operation.

Basic Addressing (16 bit)

The basic addressing scheme uses a 16-bit binary address to accommodate a maximum byte address of 65,535. The two bytes of the halfword used for addressing are specified from left to right as byte 0 and byte 1. The bits within these two bytes are numbered left to right from 0 to 7. All general registers and the CCU external registers involved in addressing storage are two bytes in length; the bit positions correspond to the basic addressing scheme. Figure B.4 shows the storage address bit positions as they are used in the basic addressing scheme. Storage addressing wraps at the maximum byte address of 65,535. This 'wrap' means that if, in the formation of a storage address, the binary representation of the address is greater than 16 bits in length, the actual address used will be only the address formed in the low-order 16 bits. For example, if the formation of a storage address uses a base address of X'A080' and a displacement of X'6010', the combined address does not include the carry of the high-order bit and therefore generates an effective address of X'0090'.

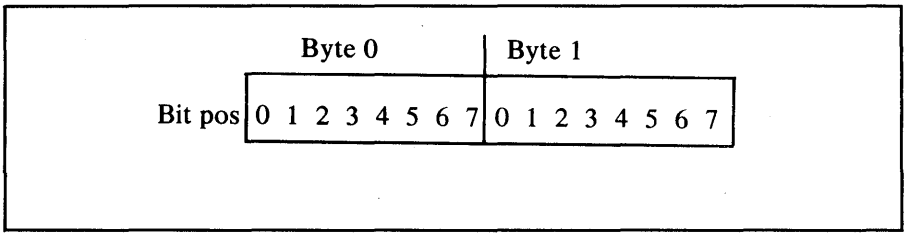

Figure B.4 Storage Address Bit Positions (without Extended Addressing)

An addressing exception is recognized if the storage address is greater than the number of installed storage locations but less than the point of storage wrap. For example, in the basic 3705 I controller, any attempt to address storage between 16,384 (or 49,152, whichever model is installed) and 65,535 results in an addressing exception.

Instructions and halfword operands must be located on integral halfword boundaries in storage. A boundary is called integral for a unit of information when its storage address is a multiple of the length of the unit in bytes. For example, a word (four bytes) must be located in storage so that its address is a multiple of the number 4. A halfword (two bytes) must have an address that is a multiple of the number 2.

Storage addresses are expressed in binary form. In binary, integral boundaries for halfwords and words can be specified only by an address in which one or two low-order bits, respectively, are zero. For example, the integral boundary for a word is a binary address in which the two low-order bit positions are zero.

Extended Addressing (18 bit)

When a controller contains more than 64K bytes of storage, the basic 16-bit address structure is not sufficient. To address the storage positions above 64K, two or four additional bits are required. (Four bits are required for 3705 II models J, K, and L with more than 256K storage.) In a 3705 with 256k bytes or less storage the two bits, designated as byte X, bits 6 and 7, allow address generation up to the maximum of 256K bytes. In a 3705 with more than 256k bytes of storage the four bits, designated as byte X, bits 4, 5, 6, and 7, allow address generation up to the maximum of 512K bytes. This addition of byte X is referred to as extended addressing. Figure B.5 illustrates the storage address bit positions used by the registers affected by extended addressing.

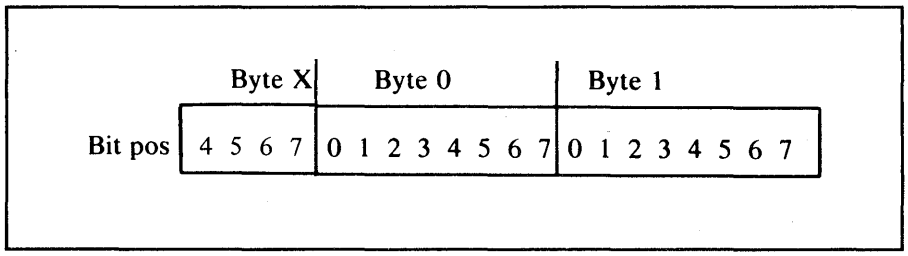

Figure B.5 Storage Address Bit Positions (with Extended Addressing)

With extended addressing, the central control unit data flow registers and all general registers are expanded to 18 or 20 bits. The additional two or four bits (byte X, bits 6 and 7 or byte X, bits 4, 5, 6 and 7) must be handled as an integral part of the register, regardless of the address being operated on. The only exceptions are:

1. byte X is ignored for output instructions not involved in addressing storage and can be set to either 1 or 0.
2. byte X is set to zeros for input instructions not involved in addressing storage.

Storage wrap and addressing exception also apply to extended addressing. With extended 18 bit addressing, however, the point of storage wrap is 256K and a carry from this value wraps back to zero. The range of addresses that cause an addressing exception is from the maximum number of storage locations installed to the point of the storage wrap. For example, with ex-

tended 18 bit addressing, if the installed storage is 180,224 bytes, any address generated between 180,224 and 262,144 causes an addressing exception.

Line Interface Addressing

The lines attached to a communication scanner are assigned line interface addresses when the machine is installed. The interface address assigned to a given line is determined by the physical location of the line interface hardware and by the type of scanner (type 1, 2, or 3) installed in the controller.

Sixteen interface addresses are assigned to each line interface base (LIB) position, permitting a total of 352 lines on the 3705 with the maximum configuration. To address each of these lines uniquely requires nine address bits. Two bits identify the scanner, three bits identify the LIB, and four bits identify the interface address on the LIB.

Whether all 16 interface addresses assigned to a given LIB position are usable depends on the type of LIB installed in the LIB position, and the type and number of line sets installed in that LIB.

Type 1 Scanner Addressing

When an interface address is passed to the program by an input X'41' instruction, the interface address bits 3-8 are placed in byte 0, bits 6-7, and byte 1, bits 0-3, of the general register specified in the instruction. Byte 0, bit 4 is set to 1, and the remaining bits are set to 0.

This alignment associates a specific two-byte storage address with each interface address. These storage addresses point to consecutive sixteen-byte blocks in storage. This area of storage can be directly addressed and contains a control block for control information and the data-handling routine addresses required for servicing an interface.

Type 2 or 3 Scanner Addressing

When an interface address is passed to the program by an Input X'40' instruction, the interface address bits 0-8 are placed in byte 0, bits 6-7, and byte 1, bits 0-6, of the specified general register. Byte 0, bit 4 is set to 1 and the remaining bits of the register are set to 0.

This alignment associates a specific two-byte storage address with each interface address. These storage addresses are aligned on halfword boundaries and are arranged so that this area in storage can be used as a vector table to direct the control program to a routine that is designed to service the particular interface type.

Storage Protection

Storage Protect is a means of notifying the control program whenever the contents of storage are accessed for unauthorized modification. This facility monitors all attempts to modify storage and execute instructions. However, due to hardware restrictions, storage protection is effective only in program level 5 and for cycle-steal channel adapter and communication scanners.

Storage is protected by a hardware comparison of separate keys assigned to the program and to storage. A user's ability to modify storage is identified by a protect key. Each program level and cycle-steal mechanism is considered a user, and each has its own protect key. Storage is divided into blocks of 2048 bytes, and each block is assigned a storage key.

When a protected area of storage is addressed, the storage key for that location is compared with the protect key associated with the user. For operands and instructions, access to the location is granted only when the two keys match. For attempts to execute an instruction, the two keys (storage and protect) must be equal. If the keys do not match, a 'protection exception' level 1 interrupt request is set. For attempts to modify a storage location, the keys match when:

1. the keys are equal
2. the protect key is X'0'
3. the storage key is X'7' (unprotected storage)

The protect keys for program levels 1, 2, 3, and 4 are fixed at zero and cannot be changed. The protect keys for the remaining users are set with the control program by an instruction which can only be executed in a protect key of zero.

The storage key of an area is determined by dividing storage into 2K blocks. Each block is then given a storage block address, from 0 to 256, relative to its position in storage. The storage keys are set by an initialization routine at IPL time.

Resetting the central control unit disables storage protection. Therefore, any instruction fetch is valid and any attempt to modify storage is permitted. The first instruction setting a storage key after a reset enables storage protect again.

IBM 3704 and 3705 Central Control Unit Review

There are five program levels in a communications controller. Four of the levels are interrupt-driven and the fifth level is scheduled by a supervisor at level four. The levels of interrupt-driven code are in a priority sequence of:

Level 1 - Hardware and program error routines

Level 2 - Line interrupt routines

Level 3 - Channel interrupt routines and deferred character service from level 2

Level 4 - Program interrupt and SVCs from level 5

Level 1 must store the registers on entry because level 1 shares a general register group with level 2. Each of the other levels, including level 5, has its own group of eight general registers. Each register 0 is the Instruction Address Register (IAR) for its level. Addressing above 64K to 256K requires 18 bits for addressing, and addressing above 256K requires 20 bits for addressing. Controllers of 64K or less have 16-bit registers, controllers of more than 64K to 256K have 18-bit registers, and controllers of more than 256K have 20-bit registers.

Storage protection occurs in 2K storage blocks. Protect keys are assigned to the supervisor code (levels 1 through 4), to level 5 code, and to each channel adapter and scanner which works in cycle-steal mode. The supervisor protect key of zero can reference any storage key value. A storage key of seven is

unprotected storage. In all other cases the storage key and protect key must match.

IBM 3704 and 3705 Central Control Unit Quiz

You are testing your own comprehension of the material in this quiz. You should answer all questions before checking your answers which are in Appendix A.

Completion:

1. The number of general registers available in one program level is _____.
2. The instruction address register (IAR) for a program level is general register number _____.
3. The 3704/3705 instruction sequence can branch as the result of the settings of hardware latches called _____ or _____ latches.
4. There are _____ sets of the hardware latches.
5. Extended addressing of 256K or less requires an address of _____ 18-bit length. Without extended addressing a bit length of _____ is required.

True or false:

6. There is no storage-to-storage move instruction.
7. Add and subtract instructions are available in binary, and there are no multiply or divide instructions.

Matching:

Match the items of Column A (program levels) with Column B (services). More than one item from Column B is valid on some items.

Column A Program		Column B Services level
8. Level 1	a.	Services line interrupts
9. Level 2	b.	Services channel interrupts
10. Level 3	c.	Program checks
11. Level 4	d.	Programmed dispatched processing
12. Level 5	e.	Management of system resources
	f.	Hardware checks
	g.	Timer interrupt
	h.	Panel interrupt

True or False:

Attempts to modify a storage location require that one or more of the following conditions of storage protection be met. Indicate a true or false to the following.

A storage protect interrupt will occurs when the:

13. storage key is 1 and the protect key is 0.
14. storage key is 0 and the protect key is 1.
15. storage key is 3 and the protect key is 3.
16. storage key is 7 and the protect key is 1.

Criterion:

If you missed more than two questions or had to refer to the text for more than two answers, you should review this topic.

IBM 3704 and 3705 Control Panel

Objective

Upon completion of this topic the student should be able to locate the control switches on a 3704 and 3705 control panel and, using the switches and the operator manual, execute any panel routine.

Program Independent Control Panel Procedures

This section describes the procedures you can execute at the 3705 control panel, regardless of the control program resident in the controller. The procedures are organized in two groups. The first group consists of the basic operating procedures that you will use most often. The second group consists of advanced operating procedures that normally are used by an experienced programmer or service representative who is familiar with the system configuration and application.

Each procedure is described in flowchart form, showing the action you should take. The 3704 and 3705 responses to your action, as well as explanatory notes and additional information, are located in the margins.

At the bottom of the page for each procedure is a list of the control panel switches, lights, and push buttons used in that procedure. The number after each one is a key to the section of the control panel diagram (Appendix D of the control panel SRL) where that switch, light, or push button is located. The diagram folds out so that you can look at it with any other page of the manual. If you are unfamiliar with the panel, the key should help you locate the controls easily.

The remote 3704 and 3705 control panel is identical to the local 3704 and 3705 control panels except that the remote panel does not have the channel interface switches and lights and the local/remote power switch. The 3705 II may be switched manually from local (channel attached) to remote (link attached).

The following manuals provide the control panel format and control sequences. Either of these manuals can be used for the following section:

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

Read the following from either of the SRL's:

Section 5: 3704/5 Control Panel Description, and Appendix D, the control panel diagram. This section provides the background for the switch settings discussed in other parts of the book.

IBM 3704 and 3705 Control Panel Review

In Appendix D of the reading assignment, you have the control panel diagrams for the 3704 or 3705. In section 5 of the control panel manual, you have an explanation of the control panel diagrams. Using the diagrams, problem determination and operating procedure sections, you should be able to perform all the panel functions.

IBM 3704 and 3705 Control Panel Quiz

Using the *Guide to Using the IBM 3704/05 Communications Controller Control Panel* (GA27-3086 or GA27-3087), determine the requirements for the following questions.

Check your answers against the answers in Appendix A.

1. Specify the proper sequence to activate level 2 and level 3 emulation line trace for subchannel 20 on a 3705.
2. Specify the proper sequence to deactivate the line trace of problem 1.
3. An additional step is required for the 3704 before activating the problem 1 emulation line trace. What is the step?

Criterion:

If you incorrectly specified the requirements on the above questions incorrectly, you should review that portion of the SRL in the reading assignment to determine the correct procedure.

IBM 3704 and 3705 Channel Adapters

Objective

Upon completion of this topic the student should be able to identify the types of channel adapters available for the 3704 and 3705 Communications Controllers and the differences in operation.

Introduction to Channel Adapters

Four types of channel adapters are available for the 3705. The type 1 CA provides attachment to an IBM System/360 or System/370 byte-multiplexor channel. The type 2, type 3, and type 4 CA's provide attachment to an IBM System/370 selector, byte-multiplexor or block-multiplexor channel. The type 3 CA enables the 3705 to be attached to System/370 models 158 and 168 tightly-coupled multiprocessor systems as a symmetrical shared controller and to uniprocessors as a controller with an alternate path capability.

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

The type 1 CA can handle only a relatively low volume of throughput and requires intervention from the 3705 control program for each four byte data-transfer burst. It is adequate, however, for many small networks and is less expensive than the other channel adapters. The type 1 channel adapter transfers data in four-byte bursts, with program intervention required after each transfer. The type 1 CA provides emulation, NCP, or PEP support to a single host. It also can provide emulation support to one host while a second type 2 or type 3 CA provides support to the first or a second host. The type 1, type 2, and type 4 CAs provide for a two-channel switch which allows connection to two host systems.

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. The type 2 channel adapter requires program intervention after each buffer or at end of message. The type 2 CA supports NCP mode only; however, it can be installed on the same 3705 with a second CA of the same or different type. A two-channel switch allows connection to two host systems.

The type 3 CA provides the same capabilities as the type 2 CA. The type 3 CA provides a dual interface to tightly coupled multiprocessor, allowing a single NCP to be addressed from either processor. The type 3 CA can be attached to two CPU channels. These two channel interfaces can be simultaneously enabled, and alternate (though not simultaneous) operation over the two interfaces is permitted.

The type 4 channel adapter has two modes of operation. Programming can initialize the channel to operate either in cycle-steal mode or in data transfers of 4, 8, 16, or 32 bytes. Emulation programming normally uses the 32-byte data transfer. NCP release 5 uses a four-byte data transfer. NCP Advanced Communications Function (ACF) uses the type 4 channel adapter in cycle steal mode.

The type 4 channel adapter in NCP cycle steal mode operates in the same manner as the type 2 or type 3 channel adapter for the length of a single NCP buffer. Up to four type 4 channel adapters can operate concurrently in NCP ACF mode.

Up to two type 4 channel adapters can operate concurrently in EP or PEP mode. Each host may use a portion of the lines; the first host which sends an enable to a line obtains the line until it is disabled. Emulation mode lines to a type 3 scanner require a type 4 channel adapter. A type 4 channel adapter can have a two channel switch, allowing attachment to two host systems.

IBM 3704 and 3705 Type 1 Channel Adapter

Objective

Upon completion of this topic the student should be able to identify the features and requirements of the type 1 channel adapter.

Type 1 Channel Adapter

The type 1 channel adapter (CA) is used for emulation support of the 2701, 2702, or 2703 Transmission Control Units and/or network control program mode. The type 1 CA is the only channel adapter available for the 3704. If the type 1 CA is installed on a 3705, it must be installed in the base module. A type 1 attachment base is a prerequisite on a 3705. The type 1 CA may only be attached to a byte multiplexor channel. A type 1 CA cannot be installed with a type 4 CA or operate with a type 3 communications scanner.

The type 1 CA provides four-byte transfers to or from the channel, with program intervention for each transfer. This intervention requires more 3705 cycles than other channel adapter types, but comes with a lower cost.

If a type 1 channel adapter is installed, it must be installed in the base module of a 3705, and optionally a type 2 or type 3 channel adapter may be installed in the first expansion module. A type 4 may not be installed in the same 3705 with a type 1 CA. The type 1 CA can be used for emulation mode and the second channel adapter used for NCP mode. The type 1 CA has a native subchannel address which is used for loading and dumping the 3704 or 3705. This same address is used for NCP mode if this CA is active only for NCP mode or both NCP and EP operation. A 3705 with 352 lines would requires only a single subchannel address for the entire network if all traffic is in NCP mode. Emulation support requires a subchannel address for each emulation line, so the type 1 CA must recognize many subchannel addresses. This recognition of multiple subchannels is simplified by dedicating a range of subchannel addresses for emulation support.

The type 1 CA relies heavily on the 3704/5 control program in order to operate successfully. Channel command decoding and interpretation, data transfer operations between the channel adapter and storage, ending status generation, and various other functions must be performed for the most part by the control program. The program control requires machine cycles to perform functions that with a different design could have been performed by hardware; the type 2 and 3 channel adapters do perform many of these functions. Reliance on programming reduces hardware cost and gives increased flexibility, but requires additional 3704 or 3705 machine cycles.

The 3704/5 is assigned a separate channel address (UCB or PUB) in the host. This address is used for loading and dumping the 3704/5. The emulation subchannel addresses serviced by the 3704/5 are separate UCB or PUB addresses and have the following requirements:

1. All emulation subchannel addresses must be on the same channel as the 3704 or 3705.
2. All UCB or PUB entries between the lowest and highest emulation subchannel serviced by a single 3704/5 must be dedicated to the 3704/5.

The emulation program is provided with low/high address limits at emulation generation time; however, these same address values are plugged in by the customer engineer at installation time. All channel selection addressing between those limits is serviced by the 3704/5. If the 3704/5 is emulating multiple control units that were not originally assigned contiguous addresses, it may be necessary to reconfigurate the system hardware for emulation.

Figure E.1 illustrates the native subchannel (NSC) and emulation channel interfaces of the type 1 channel adapter.

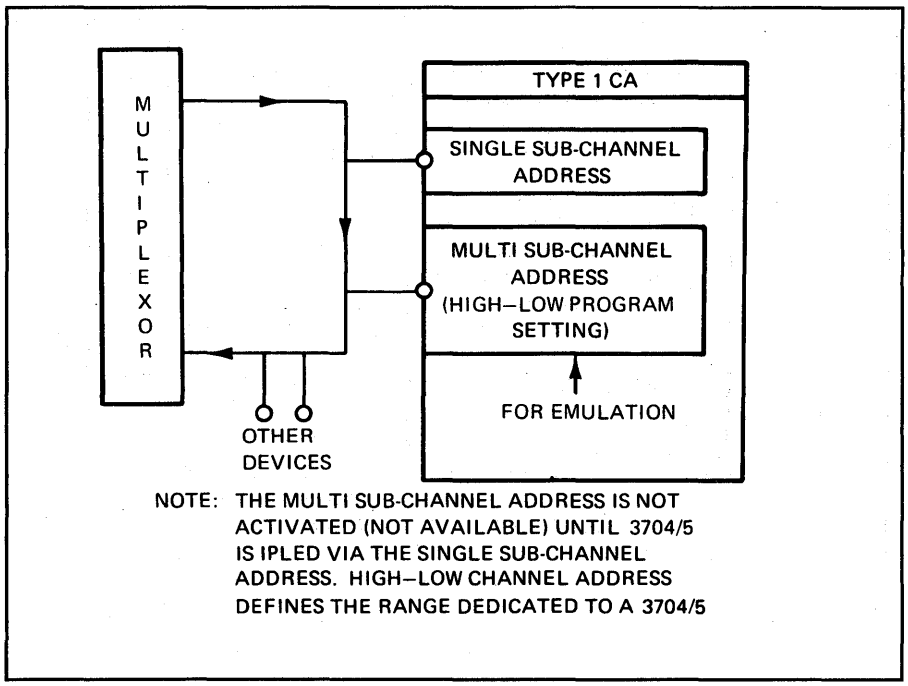

Figure E.1 Type 1 Channel Adapter Addresses

There are 352 physical line connections possible on a 3705, but only 256 channel addresses maximum on a byte-multiplexor channel. One subchannel address is required for the 3705, leaving 255 subchannel addresses for lines. With a single byte-multiplexor channel on a host using 01F for the host console, the maximum number of available subchannel addresses becomes 224. Therefore, 224 lines can be supported with the NSC channel address outside the range at some value of 000 to 01E.

The NSC address can be assigned any value in the range of 00-FF. The NSC must not be within the range of the high/low emulation subchannel assignments. If the two-channel switch feature is installed, the NSC addresses for interfaces A and B are assigned separately and can be either two different addresses or the same address used for both interfaces. Because the native mode uses only one subchannel address, the terminal address must be transferred from the host as data. The location and format of these addresses must be coordinated between the host program and the control program in the controller.

The emulation subchannel (ESC) addresses must be a group of contiguous addresses. For the 3705, the lowest address in the group can be set to zero or any multiple of 16 from 16 to 240. The highest address in the group can be

set to any value greater than the low value that is one less than a multiple of four, from three to 255. The range of recognizable ESC addresses can be set to include a minimum of four or a maximum of 256 addresses. For the 3704, the lowest address can be any even number and the highest address can be any odd number greater than the lowest address. The range of addresses can be a minimum of two or a maximum of 32. This range must be the same for both interface A and interface B if the two-channel switch feature is installed on the 3704 or 3705.

If emulation is not required, the machine can be wired by the customer engineer so that no ESC addresses are required.

A network control program with the PEP extension can use concurrently the load address for the network control program mode and the emulation addresses for emulation mode. In a 3705, a type 2 or type 3 CA in the first expansion unit can be used for the network control program mode, rather than the NSC address of the type 1 CA.

Figure E.2 shows the method that must be employed to transfer data to the host multiplexor channel using a type 1 CA. The CA has two external registers for the data bytes to be transferred. These registers must be filled or emptied as required, depending upon whether transfer is an input or output operation. Transfer is initiated by the control program by setting the appropriate bits in the service control register (another external register) together with a count of the number of bytes to be transferred. The time to provide this service is the same whether 1, 2, 3, or 4 bytes are to be transferred.

There are no hardware performance considerations for the type 1 CA because it is incapable of any cycle-steal operations, as in the type 2, type 3 or type 4 ACF CA. All the performance considerations are programming considerations. Programming must be involved with every command that is received from the channel to initiate channel operations. Programming is also involved on every data transfer of four bytes of data or less.

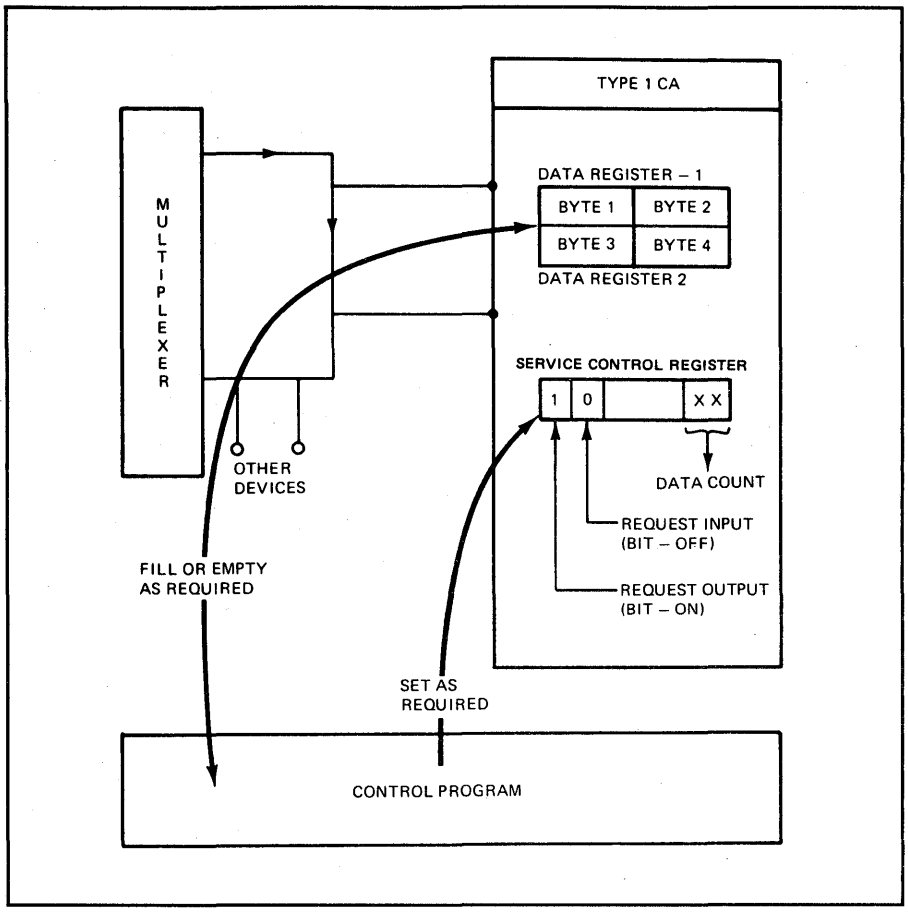

Figure E.2 Type 1 Channel Adapter Data Transfer

IBM 3704 and 3705 Type 1 Channel Adapter Review

The type 1 CA supports emulation mode and/or network control mode separately or concurrently on a byte-multiplexor host channel. The one- to four-byte transfer requires 3704/5 program intervention. The emulation mode addresses must include all the subchannels in a range from a low address to a high address. On a 3705, the low address is a multiple of 16 from zero to 240. A high address greater than the low address that is multiple of four minus one can be in the range of three to 255 on a 3705. The 3704 can have a low address of any even number and a high address of any odd number greater than the low number.

The NSC address can be any address outside the ESC low/high range. The type 1 CA can be set to ignore all ESC addresses and work in NSC mode only.

The type 1 channel adapter is the only channel adapter type supported on the 3704. The 3705 can have a type 1 channel adapter in the first module, and a type 2 or 3 channel adapter in the first expansion module. A type 1 CA cannot be installed with a type 4 CA. A manual switch on the 3704 or 3705 panel allows the 3704 or 3705 to be switched between two host systems on the same type 1 CA.

IBM 3704 and 3705 Type 1 Channel Adapter Quiz

You should be able to answer the following questions without referring to the reading assignment material. Write down your answers before consulting the answer key in Appendix A.

1. What are the requirements for a valid low subchannel address for emulation with the 3705?
2. What are the requirements for a valid high subchannel address for emulation with the 3705?
3. What are the requirements for a valid low subchannel address for emulation with the 3704?
4. What are the requirements for a valid high subchannel address for emulation with the 3704?
5. What are the requirements for a valid native subchannel (NSC) address for loading, dumping, or working in network control program mode?
6. How many data bytes (maximum) are transferred per channel interrupt?
7. To what type of channel(s) can the type 1 CA be connected?
8. What is the maximum number of emulation lines that can be controlled by a type 1 CA?

Criterion

If you missed more than one question, you should review this section.

IBM 3705 Type 2 and 3 Channel Adapters

Objective

Upon completion of this topic the student should be able to identify the features and requirements of the type 2 and type 3 channel adapters.

Type 2 and Type 3 Channel Adapters

The type 2 and type 3 Channel Adapters (CA) appear to the 3705 program support as identical interfaces. Only the host support is different in the manner of addressing the 3705. The following material states the differences in the type 2 and type 3 CA. Where a difference is not identified, you can assume the two are identical.

The type 3 CA has all the capabilities of the type 2 CA and appears to the 3705 control program as a type 2 CA. In addition, the type 3 CA enables the 3705 to be attached to tightly coupled multiprocessors as a symmetrically shared device. This symmetrical sharing means that the 3705 can be attached to two CPU's of a multiprocessor through one type 3 CA. The 3705 appears as the same device to each processor and can be sequentially accessed in exactly the same manner by each. This feature allows the CPU access methods for the 3705 to run in either CPU without having to perform 'shoulder tap' interrupt to the alternate CPU in order to perform an input or output operation to the 3705. The type 3 CA can also provide an alternate path capability for uniprocessors.

Both channel interfaces of the type 3 CA can be concurrently enabled, but concurrent data transfer is not permitted.

Because the type 2 and type 3 CA's are similar in operation, the network control program is identical for either CA. The host support of the multiprocessor uses the type 3 CA dual interface in a special manner.

Cycle Steal Operation

To relieve the system control program of the responsibility of transferring data and information between the channel adapter and storage, the CA uses cycle steal. Under hardware control, the CA 'steals' machine cycles from the central control unit (CCU). Cycle steal allows overlap of channel operations with control operations. When the channel adapter needs data from storage or has data to be stored, the CA requests a cycle steal from the CCU. A CA cycle-steal request has the highest priority in the controller, unless the type 3 scanner is installed. Therefore, unless type 3 scanner service is required, the CCU permits the CA cycle-steal request to be serviced at the end of the current machine cycle. Two bytes of information are transferred into or out of storage during each cycle steal operation.

Channel Control Word

The channel adapter control word (CW) specifies the operation to be performed by the CA in conjunction with a host processor channel operation. Control words are built by the control program according to the operation to be performed. The fields of the CW include a command code, flags, count, and data address field. All control words must reside in the lower 64K bytes of storage. CW chaining or a TIC (transfer in channel) to an address above 64K causes a CW error condition resulting in a CA level 1 interrupt.

The control word names include 'IN' or 'OUT' to denote the direction of data transfer with respect to the communication controller. Thus an IN control word must be coupled with a host channel Write and the OUT control word with a host channel Read command.

Channel Commands

The network control program includes an initial first command to identify an alternate read or alternate write for control between the NCP and host. Except for the first command of a sequence, the CW operation codes are the same for both sets of read or write sequences.

The CW operations indicate a read or write, chaining flags, the length of data, and the initial byte address.

Multiple Channel Operation

> Note: The 3704 supports the type 1 channel adapter only. Concurrent channel operation is only supported by multiple type 4 channel adapters.

A maximum of two channel adapters (except type 4 CA) can be installed in the 3705, one in the base module and one in the first expansion module. A type 2 or type 3 CA in the expansion module can coexist with a type 1, 2, 3, or 4 CA in the base module. The control program selects the channel adapter it wants to use.

If two type 2 CA's are installed, both can be attached to the same channel or each to a separate channel. Both adapters operate independently and can be enabled concurrently.

If a type 3 CA is installed, its two interfaces can be attached to a uniprocessor as a device with an alternate path capability, or each interface can be attached to a separate CPU of a tightly coupled multiprocessor. Both interfaces can be enabled concurrently, but simultaneous operation is not permitted. When a channel operation over one interface is being executed, an initial selection sequence attempt by the channel associated with the other interface causes a busy status to be presented to that channel.

Either of the type 3 channel interfaces can be manually enabled or disabled by using the channel enable/disable toggle switches located on the 3705 control panel. These toggle switches may be alternately located on a remote configuration console of a multiprocessing system.

When both interfaces are enabled, the adapter is selected by the first channel to initiate a selection sequence. If both channels simultaneously poll the type 3 CA, the adapter logic breaks the tie. If the enable/disable switch for either interface is moved to the disable position, that interface can go offline, subject to the following conditions:

1. The channel adapter is not executing a command on that interface.
2. Command chaining is not being indicated for that interface.
3. A Device End status is not pending on that interface.
4. The CPU is in a wait state.
5. The NCP is not testing the state of the 'enable' latch.

6. 'Select out' is not up on that interface.

If the switch is moved to the enable position, the interface can go online provided the CPU is in a wait state and the 3705 is not examining the state of the 'enable' latch.

Figure F.1 shows the host to the type 2 CA data transfer principle. The host issues a write command to the 3705. If the network control program is active and operating properly, the 3705 is prepared to receive data by an IN CW (Control Word) sequence. When the network control program wishes to send data to the host, an attention interrupt (the channel status modifier bit) is presented to the host. The next host command may be a read or a write, so the NCP must be prepared for either possibility. If a host read is issued, the NCP OUT CW initiates the channel adapter to send data to the host.

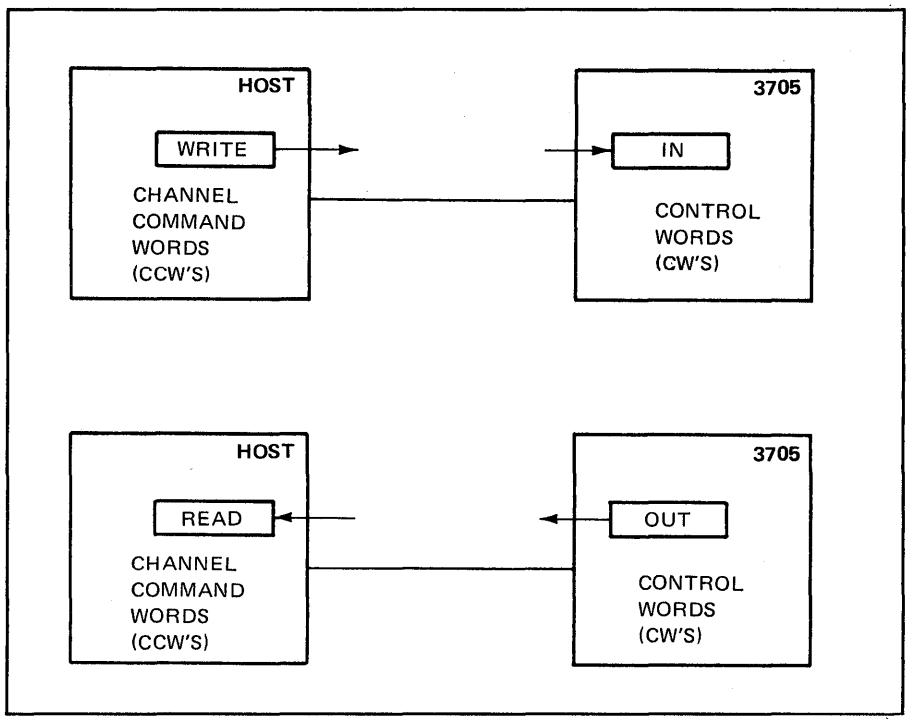

Figure F.1 Host/Type 2 CA Transfer Principle

The type 2 CA has a two-channel switch which allows the CA to be attached alternately to two hosts. The type 3 CA does not have the two-channel switch.

IBM 3705 Type 2 and Type 3 Channel Adapters Review

The type 2 and type 3 CA present an identical appearance to the 3705. The type 3 provides a symmetrical interface to tightly coupled multiprocessors. The type 3 can also be used in a uniprocessor as a primary and alternate path capability. The type 2 provides a single interface to a CPU, except for the two-channel switch which permits manual switching between two CPU's.

Type 2 and type 3 CA's are used for network control mode only. The type 2 or 3 CA can be installed in the second 3705 module, and a type 1, 2, 3, or 4 CA can be installed in the first module. The installation of a type 1 or 4 CA in the first module allows emulation support alternating with network control

program mode, or concurrent support using partitioned emulation program (PEP) extension.

The type 2 and type 3 CA uses cycle-steal operation. This method saves cycles for other processing and allows more total message throughput than a type 1 or type 2 CA.

IBM 3705 Type 2 and Type 3 Channel Adapter Quiz

You should be able to answer the following questions without referring to the reading material.

The answers are given in Appendix A.

1. To what type of channel can the type 2 or type 3 CA be connected?
2. How many bytes are transferred per cycle-steal request?
3. What specifies the data count to be transferred from the 3705 to the host?
4. How many type 2 or type 3 CA's can a 3704 have?
5. How many type 2 or type 3 CA's can a 3705 have?
6. Can both a type 1 (or type 4) and a type 2 or type 3 CA be installed on a 3705?

Criterion

If you missed more than one question, you should review this topic.

IBM 3705 Type 4 Channel Adapter

Objective

Upon completion of this topic the student should be able to identify the features and requirements of the type 4 channel adapter.

Type 4 Channel Adapter

The type 4 channel adapter has two modes of operation. Programming can initialize the channel to operate either in cycle-steal mode for the length of an NCP buffer or in 4, 8, 16, or 32 byte data transfers. Emulation programming will normally use the 32 byte data transfer. NCP release 5 uses a four-byte data transfer. NCP Advanced Communications Function (ACF) uses the cycle-steal mode.

The type 4 channel adapter in NCP cycle-steal mode operates in the same manner as the type 2 or type 3 channel adapter for the length of an NCP buffer. Up to four type 4 channel adapters can operate concurrently in NCP ACF mode. The type 4 CA attaches to byte-multiplexor, block-multiplexor, or selector channels on a System/370.

One or two type 4 channel adapters can operate concurrently in EP or PEP mode. (See Multiple Subchannel Line Access topic below.) Each host may use a portion of the lines; the first host which sends an enable to a line obtains the line until it is disabled. Each host byte-multiplexor channel supports a maximum of 255 emulation lines. Two type 4 channel adapters in EP or PEP mode support the maximum line capacity of 352 lines in emulation mode. The NCP supports one to four type 4 CA's concurrently (ACF); two of the type 4 CA's operating in NCP mode may operate in EP mode concurrently (PEP).

The type 4 channel NCS address must conform to the following:

1. If one CA type 4 is installed the NSC may be within or outside the ESC address range.
2. If two CA's type 4 are installed for EP, the NSC may be in the ESC address range, but problems may result if an attempt is made to use the NSC which was not used for the IPL.
3. If two CA's type 4 are installed for PEP, the NSC must not be in the ESC range.

Only two type 4 CA's may be used for EP mode. The same CA's may be used for NCP mode concurrently plus two additional type 4 CA's for NCP mode.

Emulation mode lines to a type 3 scanner require a type 4 channel adapter. The physical transfer is 32 bytes, but the user can specify program buffering of 4, 8, 16, 32, 64, 96, 128, 160, 192, or 224 bytes. Two buffers of the user defined size are generated for each line.

A type 4 channel adapter may have a two-channel switch if it is not installed in the same frame with a second channel adapter or a remote program loader (RPL). The two-channel switch allows attachment to two host systems.

Multiple Subchannel Line Access

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

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

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

In a PEP system with two type 4 CA's, only the lines operating in EP mode can use the multiple subchannel support.

IBM 3705 Type 4 Channel Adapter Review

The type 4 channel adapter is required for emulation support of the type 3 communications scanner. Two type 4 CA's provide EP multiple subchannel line access (MSLA) for two different access methods (one host or two hosts). The program buffering for EP can be at a user selected value up to 224 bytes. NCP release 5 uses a transfer of four bytes. NCP ACF transfers data in cycle-steal mode in the same manner as the type 2 and type 3 CA's for the length of an NCP buffer.

IBM 3705 Type 4 Channel Adapter Quiz

You should be able to answer the following questions without referring to the reading material.

The answers are given in Appendix A.

True or False:

1. The type 4 CA is required for emulation mode lines on a type 3 scanner.
2. The type 4 CA can be installed as one of multiple CA's with any other type of CA.
3. Two type 4 CA's can be attached to either one or two hosts for concurrent use of an emulation program by multiple host access methods.
4. If two type 4 CA's are installed, only emulation mode is supported.
5. If one type 4 CA is installed, and there is not a type 2 or 3 CA, then PEP cannot be used for lack of NCP channel support.

Criterion

If you missed more than one question, you should review this topic.

IBM 3704 and 3705 Communication Scanners

Objective

Upon completion of this topic the student should be able to identify the types of scanners available on the 3704 and 3705, and identify the differences in operation and capacities.

Introduction to Communication Scanners (CS)

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

The normal transmission on communication links is serial by bit. The purpose of the communications scanners is to receive or transmit bits on the link. The communications scanner may also receive bits serially from the line to build characters and deserialize characters for bit transmission on the line. The scanner may also provide character transfer into or from program buffers by cycle steal. The level of control is divided between programming and hardware. Depending upon the amount of hardware support the programming may provide (or receive from) the hardware a single bit, a single byte, or an entire program buffer.

There are three communication scanners available on the 3705. The type 1 communications scanner requires a program interrupt for each bit sent or received on a line. The type 2 scanner requires program service for each byte sent or received on a line. The type 3 scanner uses cycle steal and requires interrupts only at the end of a buffer or end of message.

The type 1 scanner requires a program interrupt on each bit sent or received. The program assembles and disassembles characters. The maximum speed line for one line on a type 1 scanner is 7200 bps on a 3705 and 4800 bps on a 3704. Only one type 1 scanner is allowed on a 3704 or 3705, and no other types of scanners can be mixed with a type 1 CS. The 3704 type 1 scanner can have up to 32 lines. The 3705 type 1 scanner can have up to 64 lines.

The type 2 scanner requires program intervention for each character sent or received. The scanner hardware assembles and disassembles characters. The 3704 type 2 CS can have up to 26 lines maximum with only one type 2 CS. The 3705 can have up to 352 lines on four type 2 scanners: 64 lines on the first CS, and 96 lines on each of the other three scanners. Type 2 scanners may be installed with type 3 scanners in any combination.

The type 3 scanner is a cycle-steal scanner requiring program intervention at the end of each buffer or end of message. The type 3 scanner supports BSC or SDLC, not start-stop. BSC is supported for either ASCII or EBCDIC. The first scanner position supports up to 48 lines; the other three scanner positions support up to 64 lines each. Eight 56,000 bps lines are the maximum speed type 3 scanner support. If emulation support is defined for this type of scanner the type 4 channel adapter is required; type 1 CA is not supported with the type 3 CS.

Line Interface Bases (LIB's) and Line Sets

The communication scanners provide the addressing and basic hardware for servicing interrupts; each address interface, however, may have special requirements. A line interface may have a local attachment, various modem requirements, and various line control types. A separate address is required for the autocall adapter (line set 1E) used to provide automatic dialing for outgoing calls in addition to the line address used for data transfer.

Several LIB types are available to handle requirements for different types of line terminations. Depending upon the type of line termination, as many as 16 communication lines can be attached through one LIB. The A and E models of the 3705 can have a maximum of four LIB's; the B and F models, a maximum of ten; the C and G models, up to 16; D and H models, as many as 22; the J, K, and L models, up to 10, 16, or 22 LIB's. The 3704 has a maximum of two LIB's on a type 2 CS.

If two channel adapters or a remote program loader (RPL) and channel adapter are installed in the same frame, LIB position 3 space is required for the channel adapter and is not available for a LIB.

Communication lines are attached to LIB's through line sets. A single line set may provide the interface for one or two communication lines depending upon the type of interface. Line sets for duplex operation require a line set for each duplex line; the line set 1H provides full duplex data transfer over two scanner addresses, each address providing data transfer in one direction.

Appendix B provides a listing of line interface bases and line sets for the 3704 and 3705 communications controllers.

Clocking

Each communication scanner is required to have at least one, but no more than four, business machine clocks. The clocks range in speed from 45.5 to 2400 bps. The clocks are used to synchronize the sending or receiving of bits on a line or to verify the clocking which is performed by a modem attached to the line.

Clocking is required at each end of the line to coordinate the sending and receiving of bits at a fixed rate. Clocking can be performed by a modem or by the controller. If modem clocking is used, each modem must provide clocking. If clocking is provided by the controller, a clock can be used for all lines which operate at the clock speed. Therefore, business machine clocking may be able to reduce the number of required clocks in modems, and in this manner reduce the cost of modems.

Internal Clocking

Internal clocking (or business machine clocking) in a 3704 or 3705 has a range from 45.5 to 2400 bps. One to four clocks can be installed in each type 1 or type 2 scanner; One or two clocks can be installed in a type 3 scanner. Only the lines attached to that specific scanner can use the clocking facilities of that scanner.

For line speeds greater than 2400 bps, an external modem must provide the clock pulses. Some line sets can operate with a business machine clock or a modem clock; some can operate only with a business machine clock.

The type 3 scanner requires the multiple speed clock (feature 9615). The optional second clock must either be a 1200 or 2400 bps clock.

External Clocking

Any transmission speed that exceeds 2400 bps requires external clocking and internal clocking. Every interface must have a business machine clock assigned, whether it is specified to be business machine-clocked or modem-clocked. For autocall interfaces and for line interfaces that are to use modem clocking, the assigned business machine clock is used to ensure that the interface is accessed periodically. The internal clock is sampling (or verifying) the external clocking. This sampling requires an internal clock operating at less than one-half the speed of the external clocking. The lowest speed clock is always used for an autocall interface.

IBM 3704 and 3705 Communications Scanners Review

Now that all types of channel adapters and communication scanners have been identified, a summary of the types of combinations can be illustrated. Figure H.1 lists the combinations for a 3704, which uses only the type 1 CA with either the type 1 or type 2 CS. Figure H.2 lists the combinations for the 3705 I, and figure H.3 lists the combinations for the 3705 II.

There are three scanners, each with a different level of processing at the hardware level and therefore requiring a different level of program support. At the hardware level the type 1 processes bits, type 2 processes a byte, and the type 3 works as a cycle steal up to a buffer.

There are many types of LIB's and line sets. Some types are only for the 3705; some are only for the 3704. A type of line or line speed may require a specific line set or one of several line set types which may allow the selection to be made on the basis of a previously selected LIB.

Each scanner uses its internal clocks up to 2400 bps to schedule bits sent or received on a line. Modem (external) clocking may be used for rates above 2400 bps, or instead of internal clocking.

Permissible Combinations
Type 1 CA and Type 1 CS
Type 1 CA and Type 2 CS

Figure H.1 Permissible Combinations of Scanners and Channel Adapters on the 3704.

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

* Second Type 4 CA can operate with EP and PEP systems only. In a PEP system, the NCP portion can operate with only one of the Type 4 CAs.

** Operation over both channel adapters allowed with PEP systems only.

*** Combination allowed in NCP systems only.

Figure H.2 Permissible Combinations of Features with the Type 3 Scanner and Type 4 Channel Adapter

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

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

Figure H.3 Permissible Combinations of Communications Scanners and Channel Adapters in the 3705 II.

IBM 3704 and 3705 Communications Scanners Quiz

The answers are given in Appendix A.

1. The maximum number of communications scanners on a 3704 is _____.
2. The maximum number of communications scanners on a 3705 is _____.
3. The maximum number of LIB's on one scanner is _____.
4. The maximum number of internal clocks per scanner is _____.
5. The maximum speed of an internal clock is _____.

Use Appendix B to assist you with the following questions.

6. What type of LIB and line set is required for single current telegraph?
7. The military has a standard interface called MIL-STD-188C for line speeds of up to 56,000 bps. What LIB and line set supports MIL-STD-188C?
8. Can IBM limited-distance line adapters or integrated modems be used on the 3704 and 3705?

9. What LIB's and line sets are used on the IBM full duplex line terminals?
10. What type of line set and LIB is required for the auto call adapter, EIA RS 366 interface?
11. What LIB and line sets (more than one type is valid) can be used on an EIA RS 232C interface for an external modem?

Criterion

If you missed more than one question, you should review this topic.

IBM 3704 and 3705 Type 1 Communications Scanners

Objective

Upon completion of this topic the student should be able to identify the features and requirements of the type 1 communications scanner.

Type 1 Communications Scanner

The type 1 communications scanner has very little hardware; most of the functions are provided by programming. The type 1 CS does not accumulate characters, but requires program service for every bit which is sent or received. The additional machine cycles required to service a level 2 program interrupt for every bit serviced greatly reduces the amount of data throughput. For small systems of 64 low-speed lines or less, the type 1 CS provides a less expensive hardware line interface.

Only one type 1 CS is available on the 3704 or 3705 I. The type 1 CS is not available on the 3705 II. The maximum line configuration on the 3705 I is 64 lines and on the 3704, 32 lines.

The 3705 I requires the type 1 attachment base for a type 1 CS; however, this is the same attachment base that is required for a type 1 channel adapter. The 3704 does not have an attachment base; the functions of controlling the type 1 CS are carried out directly by the CCU.

One to four line interface bases (LIB's) can be attached to the type 1 CS. Each LIB can have up to 16 half-duplex lines attached via line sets. A line set provides up to two line interfaces each, with up to eight line sets per LIB.

The type 1 CS can have from one to four internal business machine clocks operating at a rate of up to 2400 bps. The clocks can be used to provide synchronization for receiving or sending bits on a line, or to provide verification of modem clocking. At least one clock is required. If all clocking is external (modem clocking), the internal clock must be less than one-half the speed of the slowest modem clocking.

The type 1 CS permits the control program to communicate with a line or autocall unit interface. This communication is made through the use of input and output instructions executed by the control program to the interface addressed by the communications scanner. Data, status, and control information pertaining to each of the installed communication lines is made available to the program by the type 1 CS.

Most of the scanner functions are under direct control of the level 2 interrupt program and of processing routines that may be included in other program levels. This feature permits increased flexibility by decreasing the number of restrictions imposed by the fixed hardware. The control program must assume the responsibility of the assembly and disassembly of characters, control character recognition, translation, and line control. Character assembly and disassembly are required of the program because the type 1 CS transfers only one information bit at a time to or from the interface.

The type 1 CS differs slightly, depending on whether it is installed in a 3704 or 3705. In a 3705, the scanner supports four LIB's with a maximum of 64

lines. When installed in a 3704, the type 1 CS supports two LIB's with a maximum of 32 lines.

Operation and Data Flow

The type 1 CS hardware operates asynchronously with the other functional components of the controller.

A scan counter sequentially addresses each interface in search of a service request. If a bit service request is detected, the scanner stops on that interface and requests a level 2 program interrupt. All data and information for that interface is then made available to the control program through input instructions from the external registers. When the program executes the proper output instructions, the scanner hardware passes information to the interface hardware.

When a character service request is detected, the control program is notified by a level 2 interrupt request. The scanner does not stop for a character service interrupt, but continues generating addresses in search of a bit service request.

Because of the high priority placed on the communication lines, programming for the type 1 CS is in the level 2 interrupt program. The transferred bits and characters may be processed, however, in a lower priority program level.

When a level 2 interrupt occurs, the cause of the interrupt must be determined. A branch can then be taken to the bit service or character service routine to handle the request.

The bit service routine determines if a bit has actually been received or must be transmitted. If a bit has been received, the routine places the received bit in the proper storage location allocated for the character to be received. If a bit is to be transmitted, the routine must remove a bit from the character and pass it to the interface. When the last bit of a character has been received or transmitted, the bit service routine must request a character service interrupt from the scanner hardware.

Before exiting from the level 2 bit service routine, the program must restart the scanner by executing the proper output instruction.

Interface Scanning

All interface addresses (both used and unused) assigned to the LIB positions are scanned sequentially. These lines are physically addressed by stepping a scan counter that generates an interface address. As the scan counter steps through each interface address, a check is made to see if that interface has a request for service. If a service request is present, the scanner checks the service priority and mode of the interface. If interrupts are allowed, the scanner stops on the interface and causes a level 2 program interrupt request.

The type 1 scanner interface address (IA) needs six bits to address each interface uniquely. A type 1 CS interface address contains two fields:

1. LIB field, identifying the line interface base (LIB) position within the CS (two bits)
2. IA field, identifying the IA within the LIB (four bits)

The valid addresses of a 3704 type 1 CS are X'00' to X'1F'. The valid addresses of a 3705 type 1 CS are X'00' to X'3F'. Figure I.1 illustrates the interface addressing for the type 1 scanner and the bit values which are used to select the LIB and IA. The address is either provided by programming for output or received on input to identify a specific IA. The address points to an entry in storage which provides additional definition to the program. The hexadecimal line address is multiplied by X'10', plus X'800', to provide the storage address of a control block for the line interface.

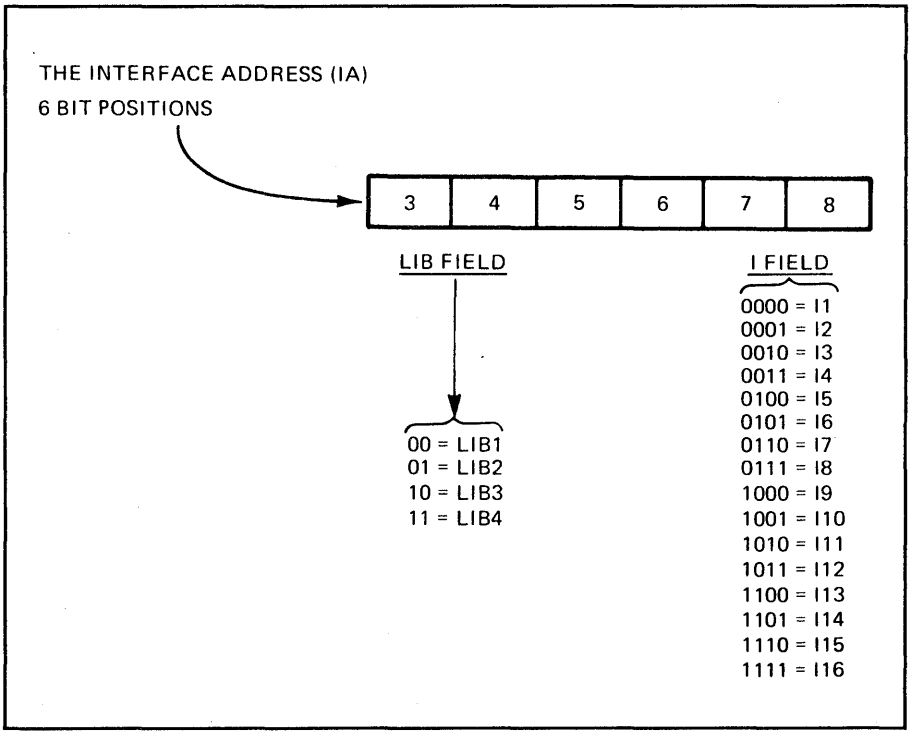

Figure I.1 Interface Addressing Type 1 CS

When the bit-service routine has obtained all necessary information pertaining to that line, the routine must execute an instruction to restart the scan counter and reset the level 2 bit service interrupt request. If character service is required, another output instruction requests a character service interrupt to be scheduled.

When not stopped to allow a particular interface to be serviced, the scan counter is stepped at a rate of 400 nanoseconds per interface in a 3705 and 600 nanoseconds per interface in a 3704.

Bit-Service Priority

Higher-speed communication lines should be serviced more frequently than lower-speed lines. For this reason the type 1 CS allows the program to assign one of two bit service priorities (high or low) to each interface.

When an interface is scanned, its assigned service priority is checked to determine whether it has high or low priority. If the service priority is high and the interface requires service on this scan, the scanner stops and causes a level 2 service interrupt request. The interrupt permits the program to service

that interface. A high-priority interface is serviced each time the line is scanned and bit service is required.

If the service priority is low, and the interface requires service, the scanner stops only if the interface being addressed is the first low-priority line encountered on that cycle of the scan counter. A cycle begins when a low-priority line has been serviced; the next low-priority line service is not allowed until the last serviced line has been passed. All high-priority lines are serviced on each cycle if they require service.

In a 3705, when the scanner addresses the first low-priority interface requiring service, the priority counter is reset to zero. The priority counter then adds one to its count for each interface scanned (high- or low-priority) following the reset. As the scanner encounters the next and any other low-priority interface, the priority counter is checked to see if a low-priority interrupt is allowed. Low-priority interrupts are not allowed until the counter reaches 65. When the scanner stops on the next low-priority interface requiring service, the priority counter is reset to zero and again, low-priority interrupts are not allowed until the counter reaches 65.

In a 3704, when a service request from a low-priority line is honored by the scanner, that line address is stored in the 'address remember register' and the 'accept low-priority' latch is reset. When the scanner is restarted by an instruction, it continues to honor service requests from lines assigned a high-priority but services no further low-priority lines until the address in the scan counter is one greater than that in the 'address remember register', at which time the 'accept low-priority' latch is set again. The scanner has then passed the address that caused the last low-priority bit service interrupt and is able to stop on the next low-priority line requesting service.

Interrupt Requests

The type 1 CS can initiate interrupt requests for either level 1 or level 2 service. Level 1 requests occur when the scanner detects an error condition affecting interface or scanner operation. Two different types of level 2 interrupt requests can occur for the purpose of handling normal service requests: the level 2 bit service request and the level 2 character service requests. The following paragraphs describe the bit service and character service interrupt requests.

Bit Service Interrupt Requests

The type 1 CS level 2 service interrupt request occurs when the scanner stops on the address of an interface requesting service. Once the scanner has stopped on an interface, the program can identify the interface by executing an input instruction. The input instruction loads a general register with the storage address associated with the interface requesting service. Figure I.2 illustrates the scanner stopped at line address X'27'. The value of the general register bits are set at 000010xxxxxx0000; the x values are set according to the line address, in this example LIB 3, interface 7 (the eighth address). The generated address is X'A70' in storage where interface address X'27' has a bit control block (BCB) which contains the defintion and program address pointers for this line. The address pointers include the address of a bit service

routine. The control fields include the area to assemble or disassemble the character.

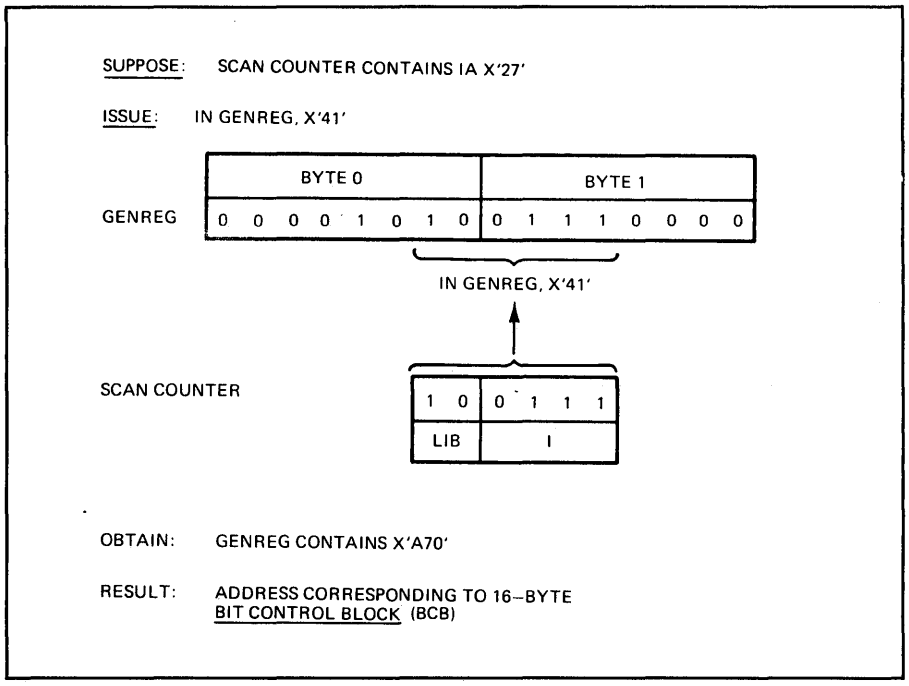

Figure I.2 Deriving the Interface Address for the Scan Counter

Figure I.3 illustrates all of the valid addresses for a type 1 CS for a 3705; and, using only LIB's 1 and 2, the valid addresses for a type 1 CS for a 3704.

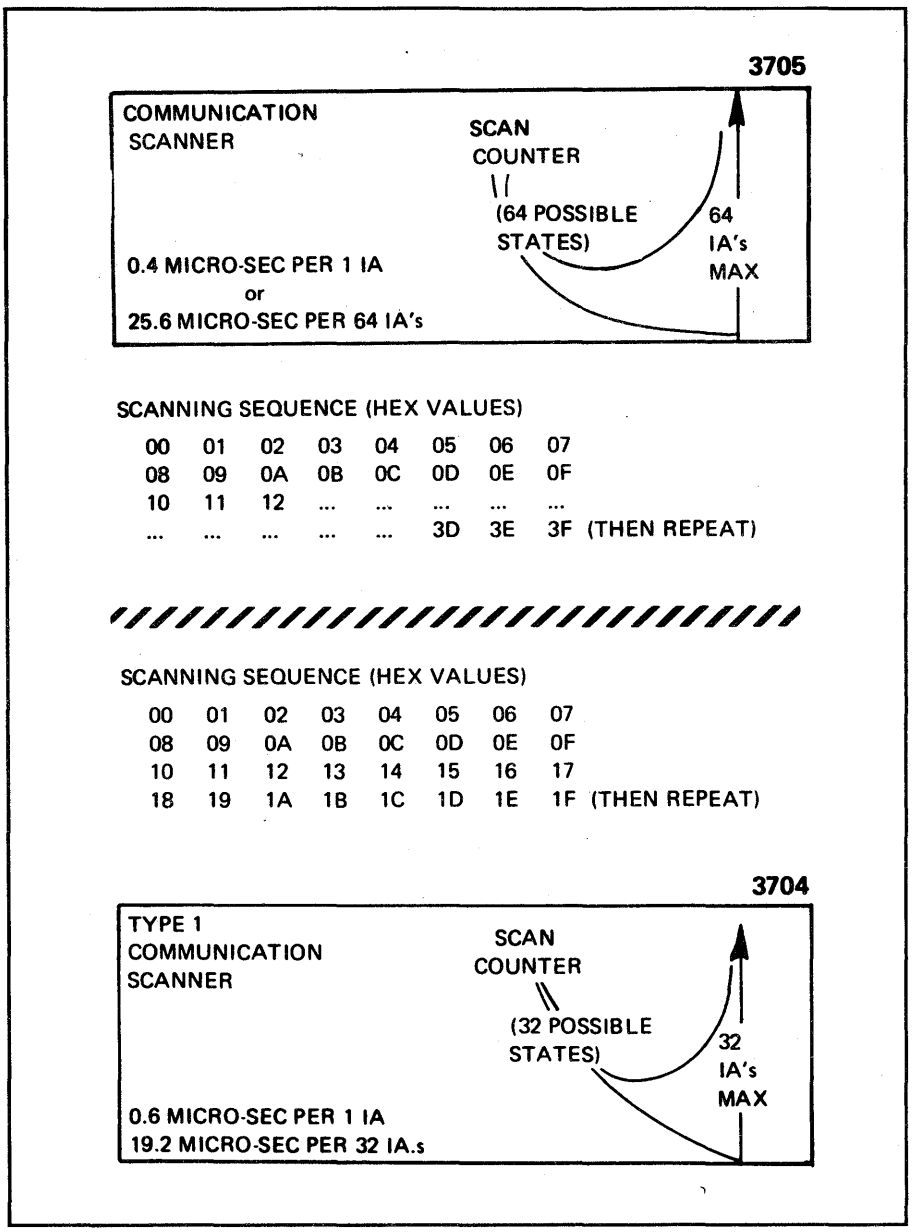

Figure I.3 Scanning Sequence for a Type 1 CS

With the scanner stopped and the interrupting interface identified, a bit service routine can gain access to various control latches and status signals in the interface hardware to allow servicing of the bit request.

When enough information has been exchanged between the program and the interface hardware, the program must execute an output instruction to restart the scanner. If the last bit of a character has been received or sent, the bit service routine must schedule a character service interrupt.

Character Service Interrupt Request

When a bit service routine detects that character service is required, the routine executes an output instruction to set the 'character service pending' latch, reset the level 2 bit service interrupt request, and start the scanner.

Once the 'character service pending' latch is set, the scanner allows a character service interrupt request to be set when either of the following conditions is satisfied:

1. The scanner passes four enabled high-priority interfaces that do not request bit service.
2. The scanner makes four complete cycles, addressing all interfaces without detecting a bit service request.

When a character service interrupt is set, the address provided by the input instruction (interface address) is forced to address X'06F0'. This is the address of a pseudo Bit Control Block (BCB) which contains the character service routine address at X'06F6'. This address identifies the interrupt as caused by a character service request and the address can be used to direct the control program to a character service routine.

The type 1 CS has only one 'character service pending' latch; therefore, the control program must ensure that this latch remains set until the character service routine processes all pending character service requests. When all character service has been completed, the routine executes an output instruction which resets the 'character service pending' latch and the level 2 interrupt request.

The type 1 CS cannot be installed with other scanner types in the same 3704 or 3705.

IBM 3704 and 3705 Type 1 Communications Scanner Review

The type 1 CS requires program assistance for every bit sent or received. This assistance means program execution on each bit, which reduces the number of lines and speed of lines that can be operated. The 3705 type 1 scanner can have 64 lines total, the 3704 32 lines total. The maximum speed of one line of 7200 (3705) bps restricts the type 1 CS to lower-speed lines. For a system with many line interfaces, the line speeds of groups of lines are much less than 4800 bps.

IBM 3704 and 3705 Type 1 Communications Scanner Quiz

The answers are given in Appendix A.

1. What is the maximum number of lines on a 3704 with a type 1 CS?
2. What is the maximum number of lines on a 3705 with a type 1 CS?
3. In the 3705, after a low-priority interface has been serviced, no more low priority interfaces will be serviced until the counter reaches what value?
4. In a 3704 or 3705, after a line interface specified as high-priority has been serviced by the scanner, what limitation value of the priority counter is required for more high-priority interface service?
5. What is the highest data rate for a single type 1 scanner line for a 3704?
6. What is the highest data rate for a single type 1 scanner line for a 3705?
7. What line interface address sequence is used by the type 1 scanner for scanning line interfaces?

Criterion:

If you missed more than two questions, you should review this topic.

IBM 3704 and 3705 Type 2 Communications Scanners

Objective

Upon completion of this topic the student should be able to identify the features and requirements for the type 2 communications scanners.

Type 2 Communications Scanner

Introduction

The type 2 communications scanner (CS) is supported on both the 3704 and 3705 communications controllers. The CS is controlled by a combination of hardware and program support. The type 2 CS is modular in that the hardware components for line attachment can be ordered in increments and field-installed as required. A minimum system contains one scanner with one line interface base (LIB) and one line set with one line on the LIB. Figure J.1 illustrates a maximum 3705 configuration with four type 2 scanners (CS1 to CS4), the LIB's, and the line sets.

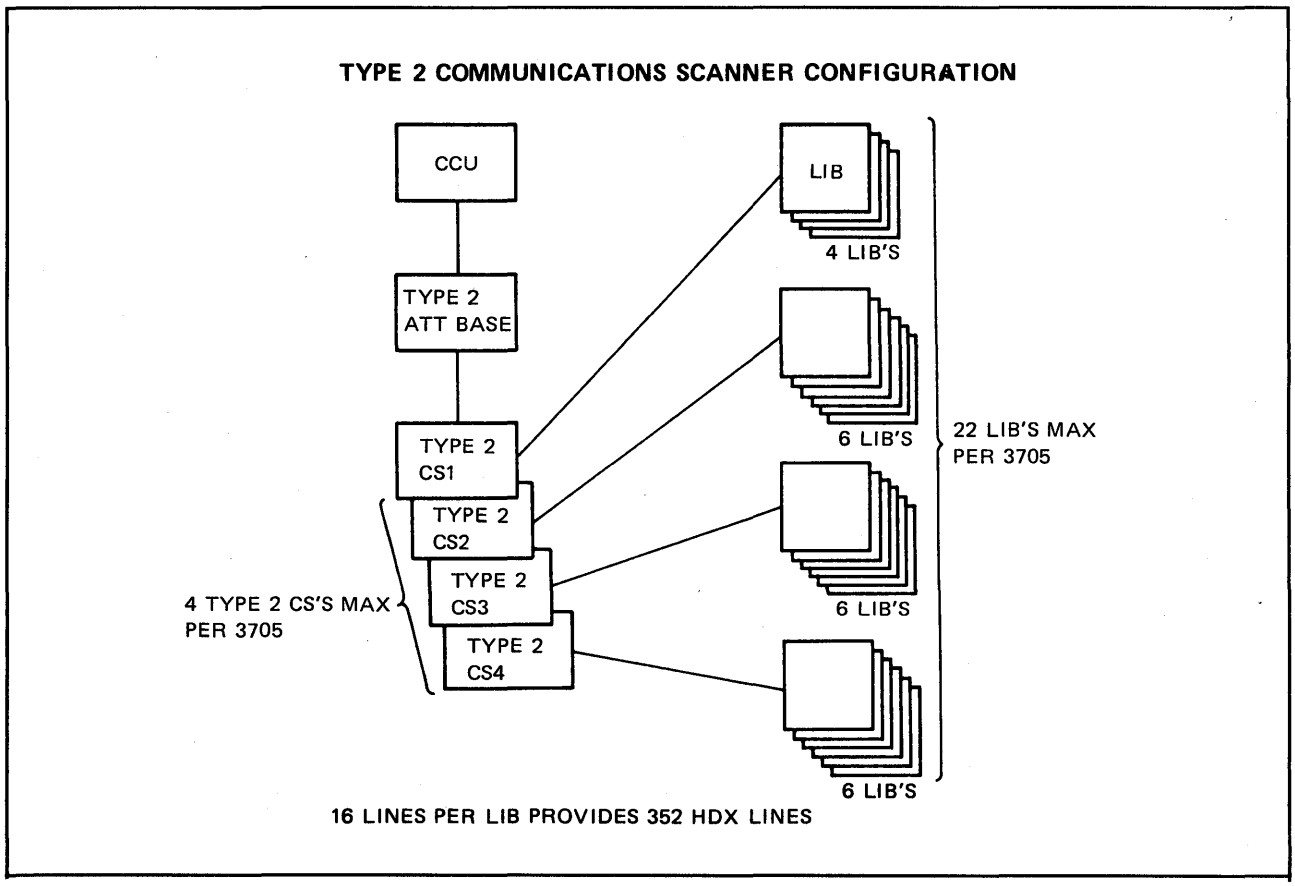

Figure J.1 Maximum Type 2 Scanner Configuration.

The components of the type 2 communications scanner are:

1. A type 2 attachment base (3705) that controls the scan addressing of the interface addresses of the lines. The 3704 type 2 scanner has the scan control built into the scanner.
2. One to four communication scanners controlled by the attachment base, that scan up to 96 lines concurrently per scanner. Only one scanner is available on the 3704.
3. One to four business machine clocks per scanner to perform clocking on lines at a rate of up to 2400 bps or to verify external clocking on modems. At least one clock is required per scanner. Internal clock verification must be less than one-half the external modem clock rate.
4. One to six line interface bases (LIB) on each communication scanner. The first 3705 scanner may have one to four LIBs. If two channel adapters or a remote program loader (RPL) and channel adapter are installed in the same frame, LIB position 3 space of the scanner in that frame is required for the channel adapter and is not available for a LIB.

   The only scanner of the 3704 may have a maximum of two LIB's, however one LIB only supports ten lines. Several types of LIBs are provided for attaching lines of varying types.
5. One to eight line sets may be attached to each LIB. Many types of line sets are available, such as autocall, low-speed local attachment, etc. The line connection or modem connection occurs at the line set; therefore, many types are required for the different arrangements of line or modem specifications. A maximum of 176 line sets are allowed on a 3705. A maximum of thirteen line sets are allowed on the 3704 type 2 scanner.
6. One or two lines may be attached to each line set, 16 lines per LIB, 96 lines per scanner (64 on the first 3705 scanner), 352 lines per 3705.

Assuming a maximum configuration, the 3705 will have:

1 Attachment base, in the base module

4 Communications scanners, one per module

16 Business machine clocks, four per communications scanner

22 Line interface bases, four in CS 1, six in CS's 2, 3, and 4

176 Line sets, eight per LIB

352 lines, two per line set, 16 per LIB, 64 on CS1 and 96 on CS's 2, 3, and 4

Assuming a maximum configuration, the 3704 will have:

1 Communications scanner (with attachment base function built in)

4 Business machine clocks

2 Line interface bases

13 Line sets

26 Lines.

The type 2 CS does the following:

1. Scans the interface addresses assigned to the LIB
2. Performs character assembly/disassembly
3. Provides character buffering
4. Causes program interrupts when character service is required.

Up to four type 2 communications scanners (CS1 through CS4) can be installed in the 3705. The type 2 CS1 supports attachment of up to four LIB's with 64 half-duplex (HDX) lines. The type 2 CS2, CS3, and CS4 can each support attachment of up to six LIB's with 96 HDX lines; thus up to 352 HDX lines can be attached to the 3705 using four type 2 communications scanners. The type 2 communications scanners can be installed with a type 1, 2, 3, or 4 channel adapter. The type 2 communications scanners can also be mixed with one or more type 3 communications scanners.

The 3704 is limited to one type 2 CS, which is operationally equivalent to and program-compatible with the 3705 type 2 CS. The 3704 type 2 CS uses the type A1 LIB in the first position which supports ten lines. A second LIB of an alternate type can provide an additional sixteen lines for a total of twenty six lines.

Interface Control Word (ICW)

The interface control word (ICW) provides the normal means by which the control program communicates with the type 2 scanner and the interface hardware.

The ICW for a type 2 CS is made up of 46 information bits and two parity bits and is physically located in the scanner local storage. Each scanner contains one ICW for each possible interface. However, even though the scanner contains the maximum number of ICW's (26 for a 3704 and 96 for a 3705), only those ICW's associated with an attached and active interface are used.

The ICW contains many fields which are set by program control or changed by activity on the line and read by program control. The key fields provide definition of line control type, the parallel data field (the character being sent or received), the serial data field (where the character is serialized or deserialized a bit at a time), and many indicators. The values of the ICW can be traced by the line trace facilities in both the emulation and network control program operation.

Operation and Data Flow

Figure J.1 illustrates the maximum configuration for a type 2 scanner. The type 2 attachment base communicates with the one to four scanners. The first scanner supports up to four LIB's; each additional scanner supports up to six LIB's, or 22 LIB's maximum per 3705. The 3704 supports one or two LIB's on a single scanner.

The interface addresses for all installed type 2 CS's in the 3705 are generated from a common type 2 attachment base. The 3704 does not have a type 2 attachment base. All necessary hardware functions provided by the type 2 attachment base are integrated within the 3704 type 2 CS. Figure J.2 shows the basic operation of the type 2 CS. A continuously running scan counter in

the attachment base places the generated interface address on an address bus that goes to all scanners simultaneously. Under program control this address can be modified by the attachment base or the scanner.

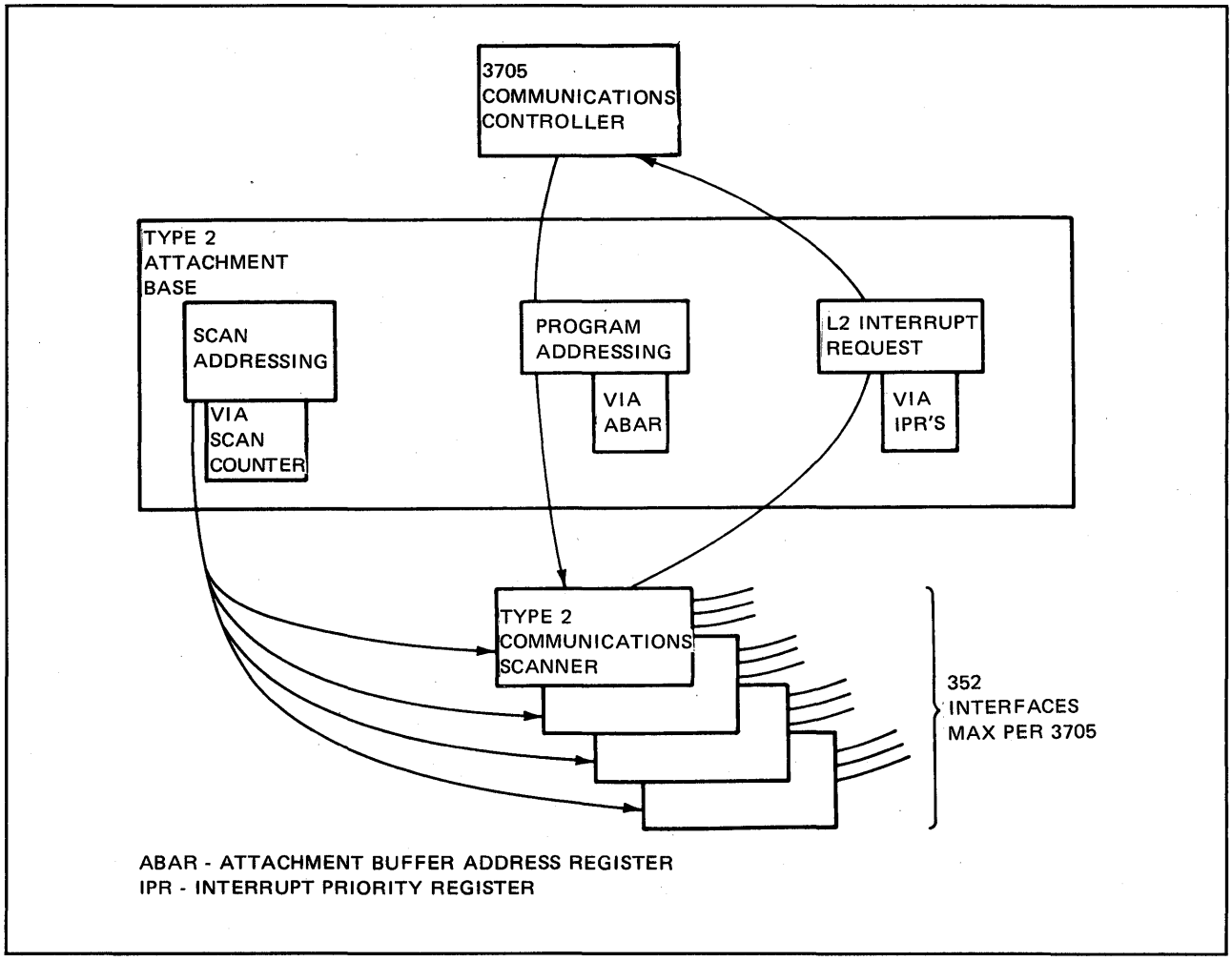

Figure J.2 Type 2 Attachment Base Functions.

The interface address is then used to address an interface control word (ICW), which is loaded into the ICW work register, where the scanner hardware determines if any action is to be performed for that interface. If no action is required, the ICW is replaced in local storage and the next addressed ICW is loaded into the work register. If the scanner determines that program intervention is required, the scanner requests a level 2 interrupt and loads the interface address into an interrupt priority register.

When the level 2 interrupt actually occurs, the address in the highest priority interrupt priority register that is active is loaded into the attachment buffer address register (ABAR). The address is then available to the control program, along with the ICW in the ICW input register.

Type 2 Scanner Registers

The type 2 scanner contains various hardware registers that are used to store information and data within the scanner and pass them between the scanner

and the control program. Through input and output instructions some of these hardware registers are available to the control program as external register addresses. The external registers required for control program access are described below.

Local Storage. Each type 2 scanner contains a local storage array to store the interface control words not being used by the scanner hardware or the control program. This storage array holds 96 control words of 48 bits each (46 information bits and two parity bits). The 3704 local storage is limited to 32 interface control words.

ICW Work Register. The type 2 scanner control logic uses the ICW work register to access, monitor, and modify an interface control word (ICW). This register is loaded each time an ICW is read out of local storage.

ICW Input Register. The control program uses the ICW input register for access to the interface control words. This register is loaded from the ICW work register and reflects the status of the ICW at the time it was read out of local storage.

Type 2 Scanner Addressing

The type 2 CS scan-addressing and program-addressing mechanism is controlled by the type 2 attachment base. The attachment base generates the basic scan address and places it on a 'line address bus' for availability to all installed type 2 CS's.

Scan Addressing

For scan addressing, the interfaces in each installed type 2 scanner (one interface per CS) are addressed simultaneously. Each scanner derives the address of the interface it is scanning from the nine-bit address (two bit CS field, three bit LIB field, and four bit I field) that the type 2 attachment base places on a 'line address bus'. The line address bus is an internal bus that carries the scan address from the attachment base to each of the communication scanners. This address, as modified by each scanner (see upper scan limit), is used not only to select a particular interface but also to address the associated interface control word (ICW) that the scanner maintains in local storage. The type 2 scanner examines this ICW and when an interface service function is required, performs that function; or when a character service requires programming action, the type 2 scanner signals the attachment base that it needs a program level 2 interrupt.

Scan Counter

The 3705 type 2 attachment base scan counter output provides the basic scan addresses for each type 2 scanner. If the scan counter output is not modified, each type 2 scanner sequentially scans 96 interface addresses. Under these circumstances, the type 2 scanner cannot handle line speeds higher than 4800 bps without having the possibility of bit overrun/underrun conditions. However, the ability to substitute some interface addresses (address substitution) and set a limit on the number of interfaces scanned (scan limit) greatly extends the capability of handling higher-speed lines. These mechanisms cause the scan counter output to be modified to allow certain interface addresses to be scanned at a different rate.

3705 Scanner Interface Addressing

The type 2 scanner of the 3705 scans each interface at the rate of 1.6 microseconds. A full scan of 96 entries takes 153.6 microseconds.

A 3705 may have up to 352 interfaces. The interface address (IA) needs nine bits to address each interface uniquely. An interface address contains three fields:

1. CS field - identifying the communication scanner
2. LIB field - identifying the line interface base position within the CS
3. IA field - identifying the IA within the LIB

Some combinations of bits in the LIB field are redundant, because no more than six LIB's can be attached to a CS (and no more than four to CS1).

The following interface addresses are valid for a 3705:

```
CS1 X'020' to X'05F'
CS2 X'0A0' to X'0FF'
CS3 X'120' to X'17F'
CS4 X'1A0' to X'1FF'
```

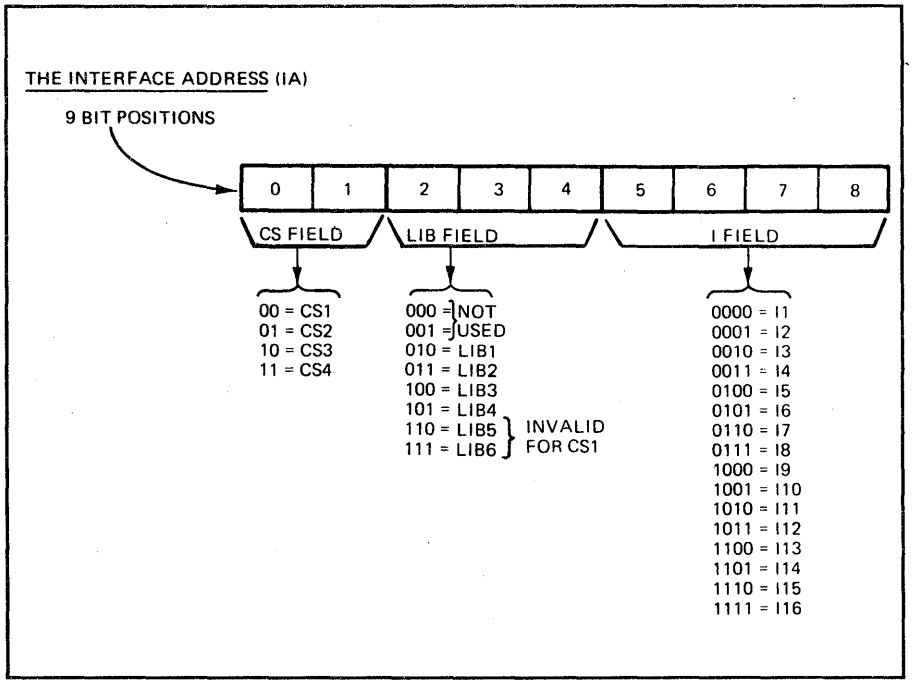

Figure J.3 Interface Addressing Type 2 Scanner

Figure J.3 illustrates the interface addressing for the type 2 scanner and the bit values which are used to select the CS, LIB, and IA. The address is either provided by programming for output or received on input to identify a specific IA. The address points to an entry in storage which provides additional definition to the program. The generated address is the hexadecimal line address multiplied by two, plus X'800' to provide a storage address of a pointer to the control block defined for that line.

3704 Scanner Interface Addressing

The 3704 type 2 scanner addressing is similar to the 3705; however the 3704 has only one scanner, so the CS field is not required. The address provides only the LIB field and the IA field. The resulting address is a pointer to a control block in storage which provides additional definition of the line interface.

The valid addresses for the 3704 for a single A1 LIB are X'0, 2, 4 through B'. If a second LIB is added, it's addresses would be X'10' to X'1F'.

The scan counter in the 3704 steps continuously through 16 different interface addresses at a rate of 1.2 microseconds per address and completes one scan of all addresses in 19.2 microseconds. However, because the LIB type A1 can support only ten lines, interface addresses 1, 3, C, D, E, and F are not available. Addresses 1 and 3 are modified to addresses 0 and 2 respectively. This change allows line speeds up to 56,000 bps to be scanned on addresses 0 and 2. Interface addresses C, D, E, and F are ignored.

If the type 2 scanner supports two LIB's, the scan counter steps through 32 different interface addresses during a 38.4 microsecond scan period. Only 26 lines addresses are valid.

Upper Scan Limit

The type 2 scanners have an upper scan limit that can be set and reset under program control. Each scanner maintains its own upper scan limit and is independent of the limits set by any of the other installed scanners. Based on the state of its 'upper scan limit' latches, a type 2 scanner may modify the 'scan counter' output from the type 2 attachment base in such a way as to limit the number of interface addresses scanned.

The actual modification of the scan address is controlled by the type 2 scanner hardware as the line address bus enters the scanner from the attachment base. Figure J.4 illustrates the basic scanning sequence of CS2, as indicated by the interface addresses.

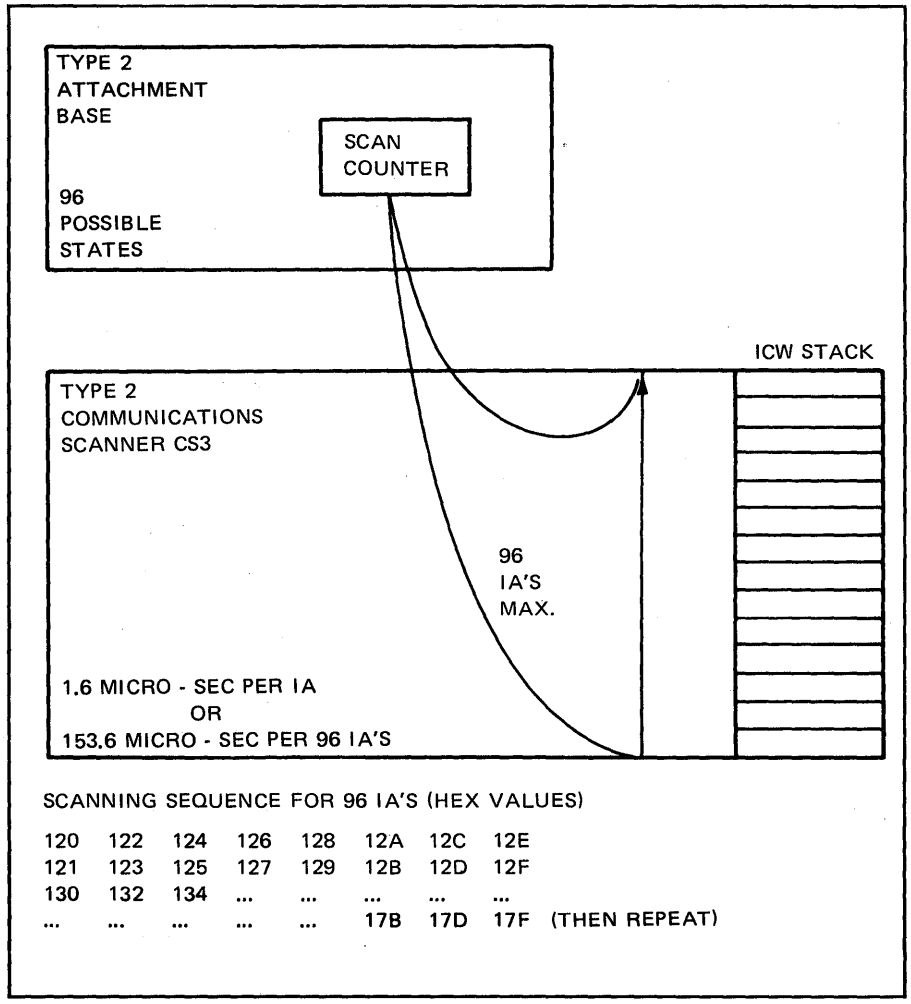

Figure J.4 Basic Scanning Sequence

The figure illustrates the CS2 addresses from X'120' to X'17F'. Note that the scanning sequence is eight even addresses, eight odd addresses, eight even addresses, etc. This sequence is important when address modification (see the next topic) changes the sequence of the addressing. If the upper scan limit is set at eight lines, then the addressing sequence is zero through seven, consecutively. All other addressing uses the eight even, eight odd sequence.

Figure J.5 illustrates the upper scan-limit latches and the LIB position affected for each setting of the upper scan limit. When the upper scan limit is set to any value other than binary 00, the scanner modifies the addresses above the limit to start at the first address again. For example, if the upper scan limit is set to allow only 16 interface addresses to be scanned, the address is modified to refer to the first address again when the scan counter output to that scanner reaches the 17th address. This modification decreases the period of time between successive scans of the remaining interface addresses to accommodate higher-speed lines. In this case, the scanner with an upper scan limit of binary 11 scans the first 16 interfaces six times in the same period of time as another scanner with no limit scans 96 interfaces. The 3704 type 2 scanner supports one or two LIB's. The default scan limit is 16 addresses, therefore,

modification of the upper scan limit is restricted to an upper scan limit of eight.

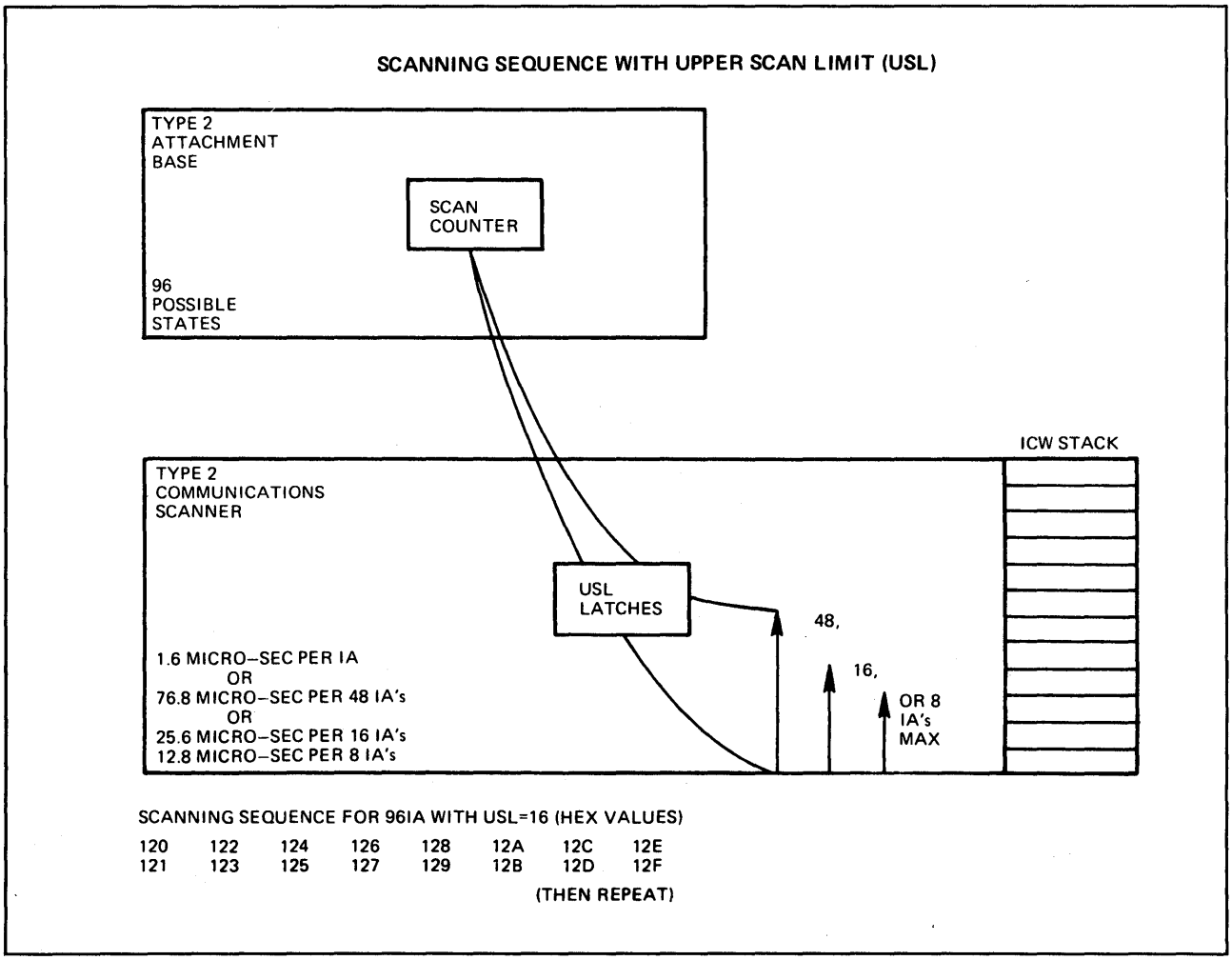

Figure J.5 Scanning Sequence with Upper Scan Limit

In effect, each pair of upper scan latches modifies the output of the scan counter so as to shorten the count loop from 96 to 48, 16, or eight IA's in a CS. Using the upper scan mechanism increases the maximum possible line-speed which can be used with a CS, as follows:

Upper Scan Limit	USL Latch Value	Effective Scan Period	Practical Maximum Line-speed
8	01	12.8	50,000 bps
16	11	25.6	19,200 bps
48	10	76.8	9,600 bps
96	00	153.6	4,800 bps

If the 3704 scanner supports two LIB's, an upper scan limit of eight or 16 can be selected as limitations. Otherwise, all 32 addresses are scanned (26 usable ICW addresses).

In figure J.5 the sequence of addresses scanned is valid except for an upper scan limit of eight. If an upper limit of eight is selected, the first eight addresses are consecutively scanned; on CS3 the addresses are hexadecimal 120, 121, 122, 123, 124, 125, 126, and 127.

Address Substitution

The output of the scan counter can be modified to cause certain addresses assigned to LIB position 1 to be substituted on the 'line address bus' in place of normal scan addresses. As a result, those addresses that are substituted are scanned by the type 2 scanner more frequently than the other addresses. Address substitution affects all installed type 2 scanners in the same manner. (Address substitution is ignored in the 3704 unless the type 2 scanner can support two LIB's.) When operating with address substitution, each scanner in the 3705 scans the substituted address or addresses every 12.8 microseconds (9.6 microseconds for a 3704 type 2 scanner with a two-LIB capability), because address substitution occurs every eighth time the scan counter changes state. This modification allows the substitution address or addresses in each scanner to handle higher line speeds, independent of the state of the scan limit.

Address substitution is controlled by a four-bit register called the substitution control register. The bits of this register may be set under program control. Up to four addresses may be substituted in any combination. An address that is selected results in some scanner addresses being ignored in order to service the selected address instead.

When a given substitution control register bit is on, a corresponding address is substituted on the 'line address bus' every eighth time the scan counter changes state. Combinations of bits 'on' in the substitution control register result in fixed-address substitution for each corresponding bit. The following shows which address is substituted and which addresses are not scanned as a result of that substitution, when different substitution control register bits (SCR) are on.

SCR value	Fixed address scanned	Addresses not scanned in every LIB
1000	IA 0 in LIB1	IA's E and F
0100	IA 2 in LIB1	IA's C and D
0010	IA 4 in LIB1	IA's A and B
0001	IA 6 in LIB1	IA's 8 and 9

Figure J.6 illustrates the scanning sequence with address substitution in the 3705. The value of the address substitution in the figure was specified as 1100, indicating by the 1-locations which lines are to be selected for substitution. The 1 in the first position selects the first line of each scanner to be substituted for all addresses ending in X'E' or X'F'. The 1 in the second position selects the second line of each scanner to be substituted for all addresses ending in X'C' and X'D'. In the scanning sequence, the normal line sequence is (in hexadecimal): 120, 122, 124, 126, 12A, 12C, 12E. In the sequence of Figure J.6 the 12E value is replaced by 120 and the 12C value is replaced by 122. The second line of scanning sequences which end in odd numbers also shows the replacement by 120 and 122 of the 12D and 12F addresses.

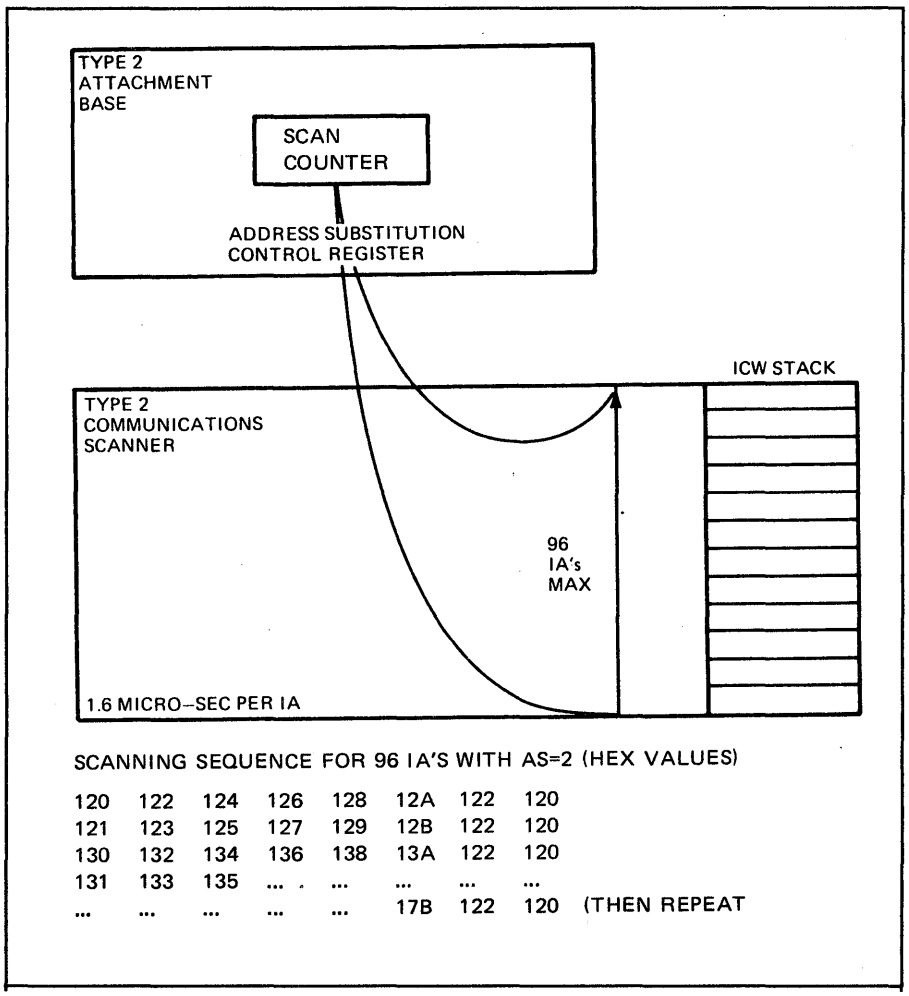

Figure J.6 Scanning Sequence with Address Substitution.

Scanning Sequence with Upper Scan Limit and Address Substitution

Consider the following network example:

One line at 50,000 bps; four lines at 7200 bps, and 36 lines at 134.5 bps.

With upper scan limit alone, you need two communications scanners. Communications scanner 1 needs an upper scan limit of eight to accommodate the 50,000 bps line and six other lines. The balance of the lines fit onto communications scanner 2 with an upper scan limit of 48 required to accommodate any 7200 bps lines.

With address substitution alone, you still need two scanners. With address substitution of 1000 for the 50,000 bps line, you can attach all the other lines, but the effective scan period is too slow for the 7200 bps lines, assuming that all lines were on CS1.

Even with the address substitution of 1111 for the 50,000 bps line and three of the 7200 bps lines, you still have too big an effective scan period for the remaining 7200 bps line.

In fact, the combination of upper scan limit and address substitution mechanisms in the same CS is permitted, and this combination can require fewer scanners in certain configurations. For the example, if we specify both upper scan limit of 48 and address substitution of 1000, all the lines fit onto a single communications scanner.

Figure J.7 illustrates the combination of upper scan limit and address substitution, with the addresses which are scanned for the example. This example illustrates the flexible method of configurating the 3705 for use in different networks or changing networks.

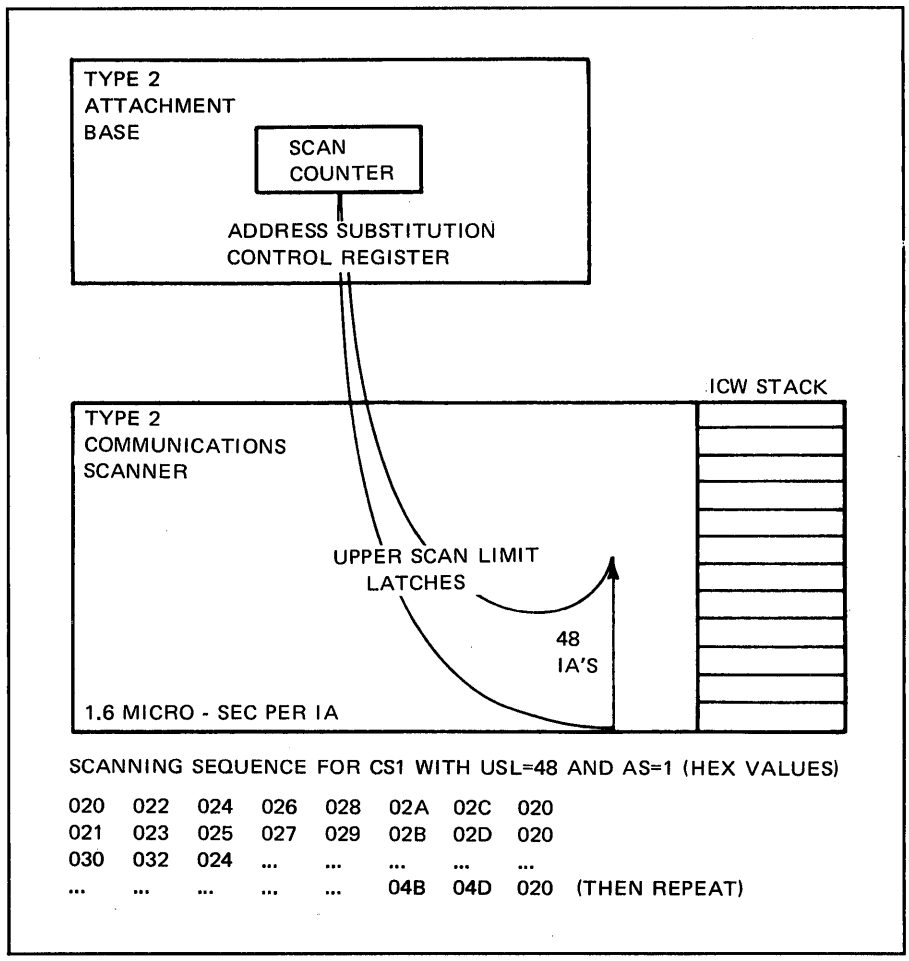

Figure J.7 Scanning Sequence with Upper Scan Limit and Address Substitution

Priority Servicing of Line

The level 2 interrupt handling of lines permits character overrun/underrun if higher speed lines are not serviced on a priority basis. On a 'first-in', 'first-serviced' basis, a 50,000 bps line can have character overrun if many low-speed lines need concurrent servicing before the 50,000 bps line is serviced again. Priority servicing is provided to avoid overruns.

The type 2 attachment base allows the user to specify one of four levels of priority for a type 2 CS line. The priority levels are 0, 1, 2, and 3, with 3 the highest priority.

There are four interrupt priority registers (IPR's) in the type 2 attachment base. Each interrupt priority register services one of the four priority levels. When a character arrives on a line, it must wait until the interface control word (ICW) is scanned for service. When that address is serviced, the type 2 CS signals for a level 2 interrupt request. The type 2 attachment base obtains the character and inserts the character in the appropriate interrupt priority register, if it is available. If the interrupt priority register has not been serviced by level 2 programming, the new address interface is bypassed until the next scan. If the line is a low-speed line, this bypass should not cause an overrun. On a high-speed line an overrun may occur.

The attachment base initiates a level 2 interrupt request if any of the interrupt priority registers need service. The level 2 routine obtains the character from the highest interrupt priority register needing service (3 is the highest priority).

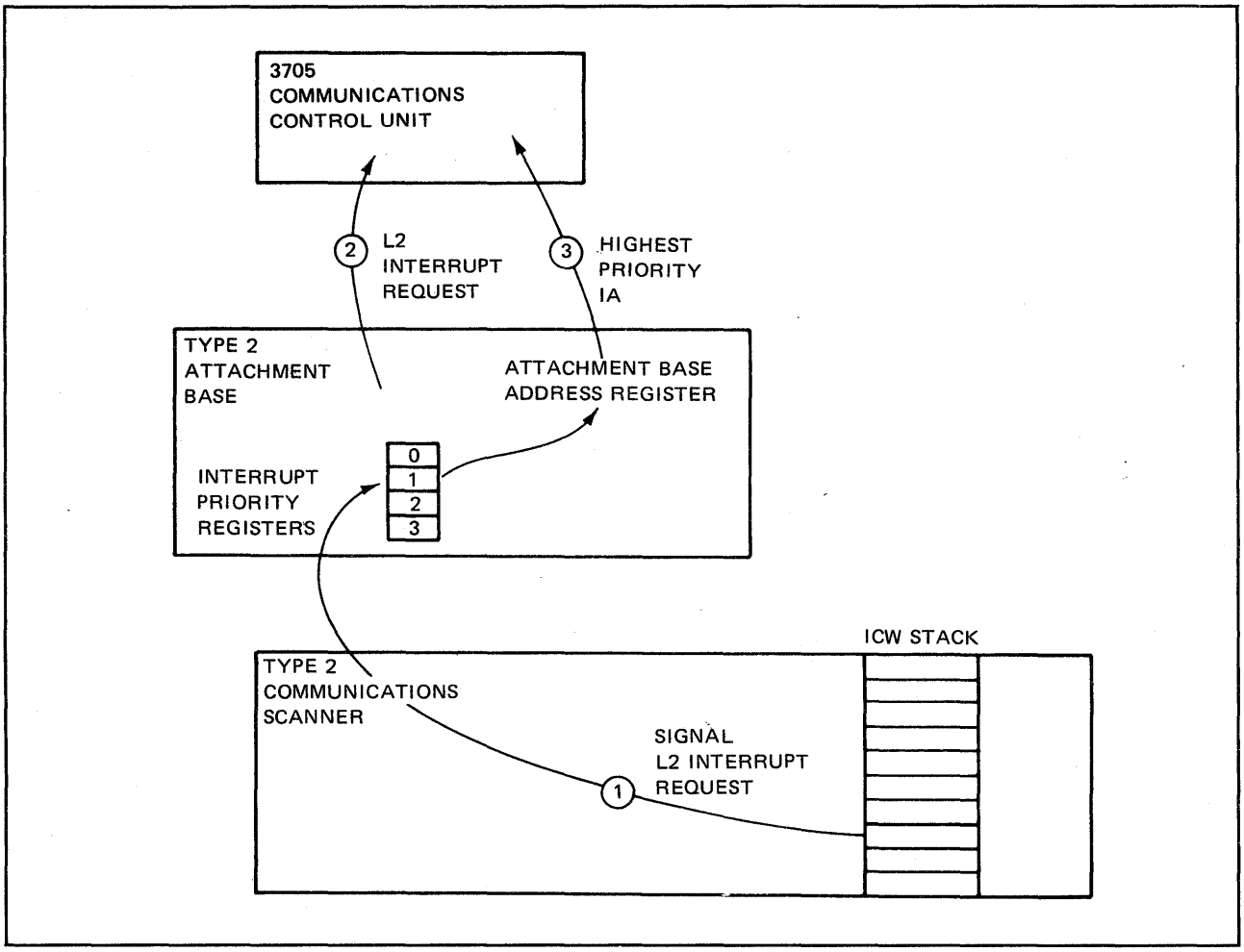

Figure J.8 Level 2 Interrupt Request.

Figure J.8 illustrates the interrupt sequence using the interrupt priority registers. First, the scanner recognizes that a character service is required and signals an interrupt request. If the interrupt priority register specified for that interface address is available, the interface control word (ICW) value is transferred to the interrupt priority register. Second, the attachment base requests a level 2 interrupt. Third, the level 2 code obtains the ICW from the highest interrupt priority register requiring service for interrupt handling.

A mix of type 2 and type 3 scanners is allowed; however, a type 3 CS may not be in the first scanner position in the base module of a 3705 I. All communications scanners must be installed in sequence; therefore, on a 3705 I with a type 3 CS, a type 2 CS is required in the base module.

IBM 3704 and 3705 Type 2 Communications Scanner Review

The type 2 CS hardware provides buffering for a character in a parallel data field of an interface control word (ICW) external register. Hardware provides for the accumulation or transmission of bits into characters. When a character has been received or sent, thereby requiring service from the program support, the requirement for service is not recognized until the line address is scanned. Address scanning is under control of the attachment base, which controls one to four scanners for addressing.

If servicing is handled without upper scan limit or address substitution, the maximum line rate is 4800 bps. Upper scan limit allows the scanner to begin at the first line after scanning only 8, 16, or 48 lines rather than the full 96 line addresses. This upper scan limit allows more frequent service on a given line address permitting speeds up to 50,000 bps. Address substitution allows one to four line addresses to be serviced per eight address scans by substituting a given line address for alternate line addresses. A combination of address substitution and upper scan limit can be specified by the user.

IBM 3704 and 3705 Type 2 Communications Scanner Quiz

The answers are given in Appendix A.

1. What is the maximum number of lines supported by the type 2 CS on a 3705?
2. What is the maximum number of lines supported by the type 2 CS on a 3704?
3. What interface addresses are scanned for each of the four scanners of a 3705?
4. How many interfaces of a type 2 scanner are scanned for each of the four scan limits?
5. What is the maximum data transfer on a line with each of the four scan limits?
6. What interface addresses are scanned for a 3704 with one LIB type A1?
7. What 3704 address interfaces provide a transfer rate of up to 50,000 bps?
8. If one line of address substitution is specified for a 3705 with two scanners, how many addresses are lost because of address substitution?

Criterion

If you missed more than one question, you should review this topic.

IBM 3705 Type 3 Communications Scanner

Objective

Upon completion of this topic the student should be able to identify the features and requirements of the type 3 communications scanner.

Type 3 Communications Scanner

Introduction

Most of the information in the section on the type 2 communication scanner applies to the type 3 communications scanner. The following primarily provides the differences between the two scanners.

The type 3 communications scanner (CS) is an improvement over the type 2 CS. The type 2 attachment base is required and the upper scan limit and address substitution of the type 2 CS apply to the type 3. The high speed select feature should be used for the type 3 CS instead of address substitution. The type 3 CS can be intermixed with type 2 CS's, except the type 3 CS cannot be installed in the first scanner position of a 3705 I. The type 3 CS is a cycle-steal scanner requiring program intervention at the end of each buffer or end of message. The type 3 scanner supports BSC or SDLC, not SS. BSC is supported for either ASCII or EBCDIC. The first scanner position (3705 II only) supports up to 48 lines and each of the other three scanner positions supports up to 64 lines.

The type 3 communication scanner (CS) is supported on the 3705 I and 3705 II. The CS is controlled by a combination of hardware and program support. The type 3 CS is modular in that the hardware components for line attachment can be ordered in increments and be field-installed as required. A minimum system is one scanner with one line interface base (LIB) and one line set with one line on the line set.

The 3705 I can have one to three type 3 communications scanners but requires a type 2 CS in the first position; type 2 or 3 CS's are allowed in any combination after the first type 2 CS. The 3705 II can have one to four type 3 CS's, with a mix of type 2 CS's in any positions upto a maximum of four scanners.

The type 3 CS uses the type 2 attachment base for control. Most of the information in the section on the type 2 communications scanner applies to the type 3 communications scanner. The points given below emphasize the differences between the two scanners.

The type 3 scanner can have up to 48 lines in the first scanner position (3705 II only), and 64 lines in all nonfirst scanner positions. The first scanner position allows three LIB's, and all nonfirst scanner positions allow up to four LIB's.

The components of the type 3 communication scanner are:

1. One to four communication scanners that scan up to 64 lines per scanner, (48 lines maximum on the first scanner position on a 3705 II, and a type 3 CS is not allowed in the first position of a 3705 I).

2. One or two business machine clocks per scanner to perform clocking on lines at a rate of up to 2400 bps or to verify external clocking on modems. At least one clock is required per scanner. Internal clock verification must be less than one-half the external modem clock rate. The multiple speed clock (150, 600, 1200 bps) is required for the type 3 CS.
3. One to four line interface bases (LIB's) on each communication scanner (three LIB's maximum on the first scanner of a 3705 II). If two channel adapters or a remote program loader (RPL) and channel adapter are installed in the same frame, LIB position 3 space of the scanner in that frame is required for the channel adapter and is not available for a LIB.
4. One to eight line sets may be attached to each LIB. Many types of line sets are available, such as autocall, low-speed local attachment, etc. The line connection or modem connection occurs at the line set; therefore, many types of line set are required for the different arrangements of line or modem specifications.

A maximum 3705 configuration of type 3 scanners is:

1. 3705 I - one type 2 scanner (first CS position) and three type 3 scanners.
2. 3705 II - four type 3 scanners.

A 3705 II with four type 3 CS's support up to 240 half-duplex lines. If one or more type 2 CS's are installed with one or more type 3 CS's, additional lines can be supported on the type 2 scanners.

The type 3 CS does the following:

1. Scans the interface addresses assigned to the LIB positions the CS supports
2. Performs character assembly/disassembly
3. Provides buffering for up to eight characters
4. Allows cycle-steal of up to two characters to or from storage as required
5. Provides translation to or from BSC ASCII as required
6. Causes program interrupts when service is required for end of buffer or end of data.

Interface Control Word (ICW)

The interface control word (ICW) provides the normal means by which the control program communicates with the type 3 scanner and the interface hardware.

The ICW is made up of the same general bits as the type 2 CS ICW; however, additional local storage buffering is provided for multiple character buffering. Each scanner contains one ICW for each possible interface. Only those ICW's associated with an attached and active interface are used. The type 3 ICW is seventeen bytes in length. In addition to the fields provided by the type 2 ICW, the type 3 ICW contains the eight-byte parallel data field array, cycle-steal byte count, and cycle-steal address.

The ICW contains many fields which are set by program control or changed by activity on the line and read by program control. The key fields provide definition of the line control type, the parallel data field (buffering of characters being sent or received), the serial data field (where the character is serialized or deserialized a bit at a time), and many indicators. The values of the ICW can be traced by the line trace facilities in both the emulation or network control program operation. The type 2 scanner trace identifies only characters as transmitted or received. The type 3 scanner trace identifies control characters separately from the data by the extended primary control field (EPCF).

The operation and data flow is basically the same as for the type 2 scanner, with the primary difference in the amount of program intervention required. Program intervention is requested by the type 3 scanner at the end of a program buffer or when an ending line control character is received or sent. Cycle steal provides the transfer of data (up to two bytes per cycle steal) without program intervention in all other cases.

Scan addressing

For scan addressing, an interface in each installed type 3 (or type 2) scanner is addressed simultaneously. A mix of type 2 and type 3 scanners are all driven concurrently by the same type 2 attachment base. Each type 3 scanner addresses each of the 64 interface addresses in sequence. The attachment base provides 96 sequential addresses and, unless modified by the upper scan limit, addresses beyond the type 3 limit of 64 are searched for service. The interface address (IA) requires the same nine-bit addressing as the type 2 scanner. Only the first four LIB position addresses are used with the type 3 scanner.

Upper Scan Limit

The type 3 scanners have an upper scan limit that can be set and reset under program control. Each scanner maintains its own upper scan limit and is independent of the limits set by any of the other installed scanners, type 2 or 3. The data on upper scan limit for the type 2 scanner applies to the type 3 scanner as well.

Address Substitution

Address Substitution for the type 3 communication scanner is the same as the type 2 scanner. If address substitution is defined for any type 2 or type 3 scanner, it affects the addressing sequence in all scanners, because it is controlled by the attachment base. Address substitution is not recommended for a type 3 CS, because the high speed select is available for the type 3 CS; high-speed select is more efficient for the type 3 CS.

High-speed Select

The type 3 CS has a high-speed select register which provides a means of servicing up to eight high-speed lines by modifying the addresses are scanned. A scan limit of 48 with the high-speed select register enables the type 3 CS to intermix low-speed and high-speed lines through the three LIB's with speeds greater than 9.6 kb restricted to LIB 1 even addresses.

The high-speed select register can select one to eight lines for high-speed service. The lines which can be selected are LIB 1 even addresses from X'020' to X'02E'. The LIB1 addresses which are modified are illustrated as follows:

High-speed Select Reg	Address Scanned	Address Replaced
X'80'	20	21 30 31 40 41 50 51 60 61 70 71
40	22	23 32 33 42 43 52 53 62 63 72 73
20	24	25 34 35 44 45 54 55 64 65 74 75
10	26	27 36 37 46 47 56 57 66 67 76 77
08	28	29 38 39 48 49 58 59 68 69 78 79
04	2A	2B 3A 3B 4A 4B 5A 5B 6A 6B 7A 7B
02	2C	2D 3C 3D 4C 4D 5C 5D 6C 6D 7C 7D
01	2E	2F 3E 3F 4E 4F 5E 5F 6E 6F 7E 7F

IBM 3705 Type 3 Communications Scanner Review

The type 3 CS hardware provides buffering for up to eight characters in a parallel data local storage array of an interface control word (ICW) external register. Hardware provides for the accumulation or transmission of bits into characters for line service, and for cycle steal to or from buffers in storage in two-byte transfers. Programming support is required at the end of each buffer or end of message.

If servicing is handled without upper scan limit, address substitution, or high-speed select, up to 64 lines can be serviced per scanner (48 on CS1). Upper scan limit allows the scanner to begin at the first line after scanning only eight, 16, or 48 lines rather than the full 64 lines; because it is under control of the type 2 attachment base, a full 96-line addressing sequence is used if upper scan limit is not specified. Address substitution is not recommended for the type 3 CS. In a mixed system of type 2 and type 3 CS's, if address substitution is specified for the type 2 scanners, address substitution will also control the scanning sequence for the type 3 scanner. High-speed select should be used to modify the addressing sequence on a type 3 CS for high-speed line servicing.

IBM 3705 Type 3 Communications Scanner Quiz

The answers are given in Appendix A.

1. What is the maximum number of lines supported by a type 3 CS1 on a 3705 II?
2. What is the maximum number of lines supported by a type 3 CS other than on the first scanner?
3. How many high-speed lines can be specified for high-speed select?
4. What scanner type is required for CS1 for a 3705 I with a mix of type 2 and type 3 CS's?
5. In a mixed type 2 and type 3 CS system, does upper scan limit defined for a type 2 CS affect the type 3 CS?

6. In a mixed type 2 and type 3 CS system, does address substitution defined for a type 2 CS affect the type 3 CS?

Criterion

If you missed more than one question, you should review this topic.

Appendix A

IBM 3704 and 3705 Communications Controller Hardware Quiz Answer Key

IBM 3704 and 3705 Hardware Introduction Quiz

1. False
2. False
3. True
4. 64K
5. 512K
6. 32
7. 352

IBM 3704 and 3705 Central Control Unit Quiz

1. 8
2. 0
3. C, Z
4. 5, (1 set per program level)
5. 18, 16
6. True
7. True
8. c, f
9. a
10. b, g, h
11. e
12. d
13. False
14. True
15. False
16. False

IBM 3704 and 3705 Control Panel Quiz

1. The panel sequence is:
   a. Place control panel in EP mode; set address/data switches B through E to X'00EE', display function select switch to function 4, and press the interrupt key.
   b. Set the display function select switch to function 4, address/data switches B through E to X'3020', and press the interrupt key. The 3 selects levels 2 and 3, 0 initiates the trace, and 20 selects the subchannel address.
2. The panel sequence is the same as problem 1 with the second set of address/data switches set to X'3120'. The 1 value stops the trace.

3. The 3704 control panel is initially off. The 'panel on' switch must be pressed before any panel functions will operate.

IBM 3704 and 3705 Type 1 Channel Adapter Quiz

1. 0, or a multiple of decimal 16 (hexadecimal 10).
2. A multiple of 4 minus 1, and greater than the low subchannel address.
3. A multiple of 2.
4. A multiple of 2 minus 1, and greater than the low subchannel address.
5. Any subchannel address outside the range of emulation subchannels.
6. 4
7. Byte multiplexor
8. 255, (one per subchannel except for NSC address)

IBM 3705 Type 2 and Type 3 Channel Adapters Quiz

1. Byte multiplexor, block multiplexor, or selector
2. 2
3. The 3705 CW length field
4. None
5. 2
6. Yes

IBM 3705 Type 4 Channel Adapter Quiz

1. True
2. False: (type 4 cannot be installed with a type 1)
3. True
4. False: (NCP can use either type 4 CA NSC address)
5. False: (NCP can use the NSC address)

Introduction to Communications Scanners Quiz

1. 1
2. 4
3. 6, (on a type 2 CS2, CS3, or CS4)
4. 4
5. 2400 bps
6. LIB type 2, line set 2A
7. LIB type 1, line set 1J
8. Yes
9. Type 1 LIB, line set 1H, 1T, or 1U

10. Type 1 LIB, line set 1E
11. 3705 type 1 LIB, line sets 1A, 1B, 1D, 1H
12. 3704 type 1 LIB, line sets 1A, 1B, 1D, 1H

IBM 3704 and 3705 Type 1 Communications Adapter Quiz

1. 32
2. 64
3. The last low-priority address serviced plus 1.
4. None
5. 4800 bps
6. 7200 bps
7. 0 to 64 in sequence.

IBM 3704 and 3705 Type 2 Communications Scanner Quiz

1. 352
2. 26
3.
```
CS1 X'020' to X'05F'
CS2 X'0A0' to X'0FF'
CS3 X'120' to X'17F'
CS4 X'1A0' to X'1FF'
```
4. 8, 16, 48, 96
5. 50,000, 19,200, 9600, 4800
6. 0, 2, 4 to B
7. 0 and 2
8. 20 (two addresses per LIB, four LIB's on CS1 and six LIB's on CS2)

IBM 3705 Type 3 Communications Scanner Quiz

1. 48 (16 lines per three LIB's)
2. 64 (16 lines per four LIB's)
3. 8
4. Type 2 CS. (A type 3 CS cannot be used in CS1 or a 3705 I.)
5. No, upper scan limit is defined separately for each CS.
6. Yes, address substitution controls all CS's.

Appendix B

IBM 3704 and 3705 Communications Controllers Line Interface Bases (LIB) and Line Sets

Additional details may be found in *Introduction to IBM 3704 and 3705 Communications Controllers* (GA27-3051).

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

LIB Type 1

The LIB Type 1 provides for attachment of the following line sets:

1. Line set 1A. External modem, two SS lines up to 1200 bps. Interface EIA RS-232C/CCITT.
2. Line set 1B. External modem, one SS line up to 1200 bps. Interface EIA RS-232C/CCITT.
3. Line set 1C. Local attachment, two SS cables up to 1200 bps.
4. Line set 1D. Two SS or synchronous lines up to 9600 bps. Interface EIA RS-232C/CCITT.
5. Line set 1E. Autocall adapter, two external automatic calling units to be associated with any switched-network communication lines attached through Line sets 1A, 1D, or 1G. Interface EIA RS-366.
6. Line set 1F. Local attachment, two synchronous terminals at speeds up to 2400 bps (RPQ 9600 bps); terminal provides its own clocking.
7. Line set 1G. External clocking, one synchronous line up to 50,000 bps (not available in the United States or Canada).
8. Line set 1H. External clocking, one duplex, leased line up to 9600 bps. Interface EIA RS-232C/CCITT.
9. Line set 1J -- (External Mil Std 188C). This line set, available only in the United States and Canada, can be attached only to a LIB Type 1 in the 3705 or a Type A1 in a 3704. This line set provides for the attachment of one SS or synchronous line at speeds up to 50,000 bps via an external modem having an interface that conforms to the requirements of the military standard 188C modem.
10. Line set 1K. One synchronous line at 40,800 or 48,000 bps (not available in the United States or Canada). Interface CCITT V.35.

3704 Modem Attachment Base for line sets 1L or 1M.

This attachment base provides for the attachment of up to two line sets 1L or 1M in any combination. The attachment base base and line sets are available only for the 3704 and a LIB type 1 or A1. Line sets 1L and 1M are equivalent to line sets 5A and 5B on the IBM 3705. This attachment base cannot

be installed in conjunction with the remote program loader, the modem attachment base with autoanswer, the duplex data attachment base, or line set 1Q.

11. Line set 1L. one synchronous point-to-point synchronous integrated modem line.

12. Line set 1M. one synchronous multipoint synchronous integrated modem line.

3704 Modem Attachment Base with Auto-Answer for line set 1P.

This attachment base provides for the attachment of up to two line sets 1P. The attachment base and line sets are available only for the 3704 with a LIB type 1 or A1 and only in the United States and Canada. Line set 1P is equivalent to line set 6A on the IBM 3705. This attachment base cannot be installed in conjunction with the modem attachment base, the duplex data attachment base, or line set 1Q.

13. 3704 Line set 1P. IBM 2400 bps switched network integrated modem. One synchronous 1200 or 2400 bps integrated modem with autoanswer. No external modem or autocall unit is required.

14. 3704 Line set 1Q. IBM 2400 bps switched network integrated modem with autoanswer and automatic call originate. One 1200 bps or 2400 bps synchronous line. No external modem or autocall unit is required.

15. Line set 1S. One synchronous line at 57,600 bps (available in the United States and Canada only) for a modem interface of CCITT V.35.

16. Line set 1T. 50k bps high speed duplex external modem. This line set will only run with the NCP program product. This line set provides for the attachment of one duplex synchronous line which has a digital interface for attachment to an external data set for up to 50,000 bps leased or switched wideband facilities.

17. Line set 1U. 56k bps high speed duplex external modem. This line set will only run with NCP program product. This line set provides for the attachment of one duplex synchronous line which has a CCITT V35 type interface for attachment of one duplex synchronous line facility with line speeds up to 57,600 bps.

18. Line set 1W. Local attachment, one half-duplex line up to 57,600 bps.

3704 Duplex Data Attachment Base for line sets 1X and 1Y.

This attachment base provides for the attachment of up to two line sets 1X and 1Y in any combination. The attachment base and line sets are available only for the 3704 with a LIB type 1 or A1. Line sets 1X and 1Y are equivalent to line sets 11A and 11B on the IBM 3705. The duplex data attachment base cannot be installed in conjunction with the remote program loader, the modem attachment base with autoanswer, or line set 1Q.

19. Line set 1X. IBM 2400 bps point-to-point leased line duplex data integrated modem; one synchronous leased line at 1200 or 2400 bps. No external modem is required.

20. Line set 1Y. IBM 2400 bps multipoint control duplex data integrated modem; one synchronous leased line 1200 or 2400 bps. No external modem is required.

21. Line Set 1Z. Local Attachment, one full-duplex line up to 57,600 bps.

LIB Type A1 (3704)

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

LIB Type 2

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

1. Line set 2A. Telegraph single current. Two single-current telegraph lines up to 200 bps.

LIB Type 3

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

1. Line set 3A. Limited distance two-wire line adapter. Two SS lines up to 134.5 bps and up to 4.75 wire miles.

2. Line set 3B. limited distance four-wire line adapter. Two SS lines up to 134.5 bps and up to 4.75 wire miles.

LIB Type 4

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

1. Line set 4A. Limited distance two-wire line adapter. Two SS lines up to 600 bps and up to 8.25 wire miles.

2. Line set 4B. Leased line two-wire line adapter. Two SS lines up to 600 bps. No external modems required.

3. Line set 4C. Leased line four-wire line adapter. Two SS lines up to 600 bps. No external modems required.

LIB Type 5

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

1. Line set 5A. IBM 2400/1200 bps point-to-point leased line integrated modem. One synchronous line at 1200 or 2400 bps. No external modem is required.

2. Line set 5B. IBM 2400/1200 bps multipoint control leased line integrated modem. One synchronous line at 1200 or 2400 bps. No external modem is required.

LIB Type 6

The LIB Type 6, available for the 3705 only, provides for the attachment of the following line sets (this LIB is available only in the United States and Canada):

1. Line set 6A. IBM 2400/1200 bps switched network integrated modem. One synchronous line at 1200 or 2400 bps with autoanswer. No external modem or autocall unit is required.

LIB Type 7

Provides for attaching 2400 bps switched network integrated modem and auto-call unit. No line sets are required with this LIB. LIB type 7 is only available in the United States and Canada.

LIB Type 8

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

1. Line set 8A. IBM 1200 bps leased integrated modem. Two synchronous lines up to 1200 bps in the United States. In countries outside the United States, this line set provides two SS at 600 bps or two synchronous lines at 600 or 1200 bps. 3705 only.
2. Line set 8B. IBM 1200 bps switched network integrated modem. Two synchronous lines up to 1200 bps. For 3704, one half-duplex line up to 1200 bps. The line set includes one (for the 3704) or two (for the 3705) IBM 1200 bps integrated modems equipped with autoanswer. Available in the United States and Canada only.
3. Line set 8C. IBM 1200 bps leased line integrated modem with break. One half-duplex SS or synchronous line up to 1200 bps. 3704 only. The break capability is supported for SS operation up to 300 bps. No external modem required.
4. Line set 8D. IBM 1200 bps switched network integrated modem with break. One half-duplex SS or synchronous line up to 1200 bps. 3704 only. The break capability is supported for SS operation up to 300 bps. No external modem required.

LIB Type 9

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

1. Line set 9A. IBM 1200 bps switched network integrated modem with automatic call originate. One synchronous line up to 1200 bps. Includes one IBM 1200 bps integrated modem equipped with the autoanswer and automatic call originate functions. No external modems or autocall units are required.

LIB Type 10

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

1. Line set 10A. IBM 1200 bps leased duplex integrated modem. One synchronous duplex leased line up to 1200 bps. No external modem is required.

LIB Type 11

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

1. Line set 11A. IBM 2400 bps point-to-point leased line duplex data integrated modem. One synchronous duplex leased line of 1200 or 2400 bps. No external modem is required.
2. Line set 11B. IBM 2400/1200 bps multipoint control integrated modem. One synchronous duplex leased line at 1200 or 2400 bps. No external modem is required.

LIB Type 12

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

1. Line set 12A. IBM 1200 bps leased line integrated modem with break. Two half-duplex SS or synchronous leased lines up to 1200 bps. The break capability is supported for SS operation up to 300 bps. No external modems are required.
2. Line set 12B. IBM 1200 bps switched network integrated modem with break. two half-duplex SS or synchronous switched lines up to 1200 bps. The line set includes two IBM 1200 bps integrated modems with break and autoanswer capability. The break capability is supported for SS operation up to 300 bps. No external modems are required.

Glossary

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

Attachment Base: A required feature for support of the 3705 adapters. The type 1 attachment base provides common controls to the central control unit for both the type 1 scanner and the type 1 channel adapter. The type 2 attachment base provides common controls to the central control unit and line addressing controls for the type 2 and type 3 scanners.

Bit Service: The process of character assembly or disassembly.

Buffer: A temporary storage area for data.

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

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

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

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

Character Service: The process by which a character is moved from the storage area (ICW or BCB) where it was assembled to a buffer.

Communications Controller: A channel or link attached controller which transfers data between communication devices under control of commands from a IBM System/370.

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

Communication Scanner (CS): A controller hardware unit that provides the interface between line interface bases (LIB's) and the central control unit. The communication scanner monitors the communication lines for service requests.

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

Duplex Line: A communication line having two independent data paths over which data can be transmitted in both directions simultaneouly. (Also called a full-duplex line).

Emulation Program: A control program for the controllers which provides for the emulation of the 2701 Data Adapter Unit, the IBM 2702 Transmission Control, and 2703 Transmission Control. Generated by the user from a library of IBM-supplied modules.

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

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

Line Interface Base (LIB): A controller hardware unit that provides for the attachment of communication lines to the controller.

Local Communications Controller: A communications controller attached to a host processor by a channel adapter.

Modem: (MOdulator-DEModulator) A device that modulates and demodulates signals transmitted over communication facilities. See also Line Adapter.

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

Network Control Program: A program to manage the controllers, generated by the user from a library of IBM-supplied modules.

Partitioned Emulation Program (PEP): A control program which provides the functions of both the Emulation Program and Network Control Program. Generated by the user from a library of IBM-supplied modules.

Remote Communication Controller: A controller that communicates over a link with a local communications controller, instead of being attached directly to the host processor by a channel adapter.

Two-channel Switch: A hardware feature that allows the controller to be attached to two CPU channels through a single type 1, type 2, or type 4 channel adapter.

SDLC Link: A communications line over which communications are conducted using the synchronous data link control (SDLC) scheme.

Uniprocessor: A computer employing one processing unit.

List of Abbreviations

ABAR	Attachment Base Address Register
ASCII	American Standard Code Information Interchange
BCD	Binary Coded Decimal
BSC	Binary Synchronous
CA	Channel Adapter
CCITT	Comite Consultatif International Telegraphique et Telephonique (Consultative Committee on International Telepraphy and Telephony)
CPU	Central Processing Unit
CS	Communication Scanner
CW	Channel Control Word
EBCDIC	Extended Binary Coded Decimal Interchange Code
EP	Emulation Program
ESC	Emulation Subchannel (Address)
IPL	Initial Program Load
IPR	Interrupt Priority Register
MSLA	Multiple Subchannel Line Access
NCP	Network Control Program
NSC	Native Subchannel (Address)
PCI	Program Controlled Interrupt
PEP	Partitioned Emulation Program
TWX	Teletypewriter Exchange
VTAM	Virtual Telecommunication Access Method
WU	Western Union

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