



**DATA**

**COMMUNICATIONS**

**CONCEPTS**

# Preface

This manual contains general information about data communications. It is intended for persons planning or using a data communication system with IBM General Systems Division products.

To understand the content of this manual, you must be familiar with data processing concepts.

The manual defines data communications, explains the benefits of data communications, and describes how data communications can be used with data processing.

To describe the components of a data communication system, a sample system is shown that includes all the basic components (such as terminals, computers, and programs) of a GSD data communication system. The sample system also includes a brief description of the function of each component. Subsequent chapters then describe the components in more detail. In addition, there are sample data communication system configurations using IBM General Systems Division products and other related IBM equipment.

The appendixes contain a glossary of data communication terms and a bibliography of publications containing more information on data communications or the products discussed in this manual.

All examples and illustrations in this manual are typical uses of data communications and do not describe user systems now installed. Actual costs of equipment or transmission services are not listed in this manual. Contact your IBM marketing representative or your local IBM branch office for this information.

## Related Publications

See Appendix B, *Bibliography* for related publications.

## Third Edition (December 1978)

This is a major revision of, and obsoletes GC21-5169-1. Subsequent versions of this manual will reflect any further technical changes which may occur.

This publication contains examples of data and reports used in daily business operations. To illustrate them as completely as possible, the examples include the names of individuals, companies, brands, and products. All of these names are fictitious and any similarity to the names and addresses used by an actual business enterprise is entirely coincidental.

Use this publication only for the purpose stated in the *Preface*.

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<b>CHAPTER 1. INTRODUCTION</b> . . . . .	<b>1</b>	<b>IBM Series/1 4990 Model 1 Communications Console for the 4987</b> . . . . .	<b>50</b>
What is Data Communications? . . . . .	1	<b>IBM Series/1 Auto-Call Originate Attachment Card (RPQ)</b> . . . . .	<b>50</b>
What are the Benefits of Data Communications? . . . . .	1	<b>Adapters for the IBM System/3</b> . . . . .	<b>51</b>
What are the Uses of Data Communications? . . . . .	1	Binary Synchronous Communications Adapter . . . . .	51
Data Entry, Inquiry, and Record Update . . . . .	3	<b>Binary Synchronous Communications Controller</b> . . . . .	<b>52</b>
Remote Batch Entry . . . . .	5	Multiple Line Terminal Adapter . . . . .	53
Remote Job Entry . . . . .	6	Integrated Communications Adapter . . . . .	53
<b>CHAPTER 2. COMPONENTS OF A DATA COMMUNICATIONS SYSTEM</b> . . . . .	<b>7</b>	Local Communications Adapter . . . . .	54
<b>CHAPTER 3. COMMUNICATION NETWORKS</b> . . . . .	<b>9</b>	Local Display Adapter . . . . .	54
Switched Channels . . . . .	10	Display Adapter . . . . .	55
Nonswitched Channels . . . . .	10	Integrated Display Adapter . . . . .	55
Switched Versus Nonswitched . . . . .	11	<b>Adapters for the System/7</b> . . . . .	<b>55</b>
Point-to-Point and Multipoint . . . . .	11	Asynchronous Communications Control Attachment (ACCA) . . . . .	56
Controlling the Devices on a Point-to-Point Channel . . . . .	12	Asynchronous Communications Control Adapter 50KB (RPQ D08000) . . . . .	56
Controlling the Devices on a Multipoint Channel . . . . .	14	Asynchronous Communications Control Adapter 1200 (RPQ D08001) . . . . .	56
Terminals . . . . .	18	Asynchronous Communications Control Master (RPQ S65005) . . . . .	57
Point-to-Point Versus Multipoint . . . . .	19	Binary Synchronous Communications Adapter (BSCA) . . . . .	57
Full and Half Duplex . . . . .	20	5098-N03 Binary Synchronous Communications Module (RPQ D08080) . . . . .	58
Transmitting the Data . . . . .	21	Binary Synchronous Communications Adapter-9600 BPS (RPQ S65035) . . . . .	58
Data Validity . . . . .	22	Teleprocessing Multiplexer Feature (RPQ D08010) . . . . .	58
Transmission Efficiency . . . . .	23	5098-N01 Teleprocessing Multiplexer Module (RPQ D08011) . . . . .	58
Buffers . . . . .	24	<b>Adapters for the IBM System/32</b> . . . . .	<b>59</b>
Modems . . . . .	26	Binary Synchronous Communications Adapter . . . . .	59
<b>CHAPTER 4. SYNCHRONIZATION AND DATA LINK CONTROL</b> . . . . .	<b>27</b>	Synchronous Data Link Control Adapter . . . . .	60
Asynchronous . . . . .	28	<b>Adapter for the IBM System/34</b> . . . . .	<b>60</b>
Binary Synchronous . . . . .	31	<b>Adapter for the IBM 5230 Data Collection System</b> . . . . .	<b>62</b>
Synchronous Data Link Control . . . . .	35	<b>CHAPTER 6. TERMINALS</b> . . . . .	<b>63</b>
Control Field Format . . . . .	36	The IBM Communicating Magnetic Card Selectric Typewriter . . . . .	64
Controlling the Communication Link . . . . .	38	The IBM 1050 Data Communication System . . . . .	65
Systems Network Architecture . . . . .	42	The IBM 2740 and 2741 Communication Terminal . . . . .	66
<b>CHAPTER 5. COMMUNICATION ADAPTERS</b> . . . . .	<b>43</b>	The IBM 2770 Data Communication System . . . . .	67
Adapter Functions . . . . .	44	The IBM 2780 Data Transmission Terminal . . . . .	68
<b>Adapters for the IBM Series/1</b> . . . . .	<b>44</b>	The IBM 2972 General Banking Terminal System . . . . .	69
Asynchronous Communications Single-Line Control . . . . .	44	The IBM 3270 Information Display System . . . . .	70
Asynchronous Communications 8-Line Control . . . . .	45	The IBM 3735 Programmable Buffered Terminal . . . . .	71
Asynchronous Communications Four-Line Adapter . . . . .	45	The IBM 3741 Data Station and the IBM 3741 Programmable Work Station . . . . .	72
Binary Synchronous Communications Single-Line Control . . . . .	46	The IBM 3747 Data Converter . . . . .	73
Binary Synchronous Communications Single-Line Control/High Speed . . . . .	47	The IBM 3767 Data Communication Terminal . . . . .	74
Binary Synchronous Communications Eight-Line Control . . . . .	47	The IBM 3770 Data Communication System . . . . .	75
Binary Synchronous Communications Four-Line Adapter . . . . .	48	The IBM 3780 Communications Terminal . . . . .	76
Synchronous Data Link Control (Single-Line) Communications Indicator Panel . . . . .	48	The IBM 5100 and 5110 with Asynchronous Communications . . . . .	77
IBM Series/1 4987 Programmable Communications Subsystem . . . . .	49	The IBM 5110 with Binary Synchronous Communications . . . . .	78
		The IBM 5230 Data Collection System . . . . .	79
		The IBM 5250 Information Display System . . . . .	80

<b>CHAPTER 7. USING GSD PRODUCTS WITH COMMUNICATIONS</b>	<b>83</b>
The IBM Series/1	83
The Series/1 Realtime Programming System	84
IBM Series/1 Programmable Communications Subsystem Preparation Facility	86
IBM Series/1 Programmable Communications Subsystem Execution Support	86
IBM Series/1 Remote Job Entry (PRPQ)	87
Binary Synchronous Communications Control Program Support (PRPQ)	87
Control Program Support Auto-Call Support (PRPQ)	88
IBM Series/1 Intelligent Terminal Subsystem (FDP)	88
The IBM System/3	90
The RPG II Telecommunications Feature	91
The RPG II 3270 Display Control Feature	92
The Data/3 Program Product	93
The Communications Control Program	94
Model 15D Channel Connected Systems	101
Terminal Query Facility	104
BSCA Multiline Multipoint Feature	104
Multiple Line Terminal Adapter Input/Output Control System	104
Remote Job Entry Work Station Feature	105
MULTI-LEAVING Remote Job Entry/Work Station Feature	105
The IBM System/7	106
Customer Information Control System (CICS)	107
Communication Control Application Program/7 (CCAP/7)	108
Remote Data Concentrator Program	110
The IBM System/32	112
Binary Synchronous Communications	112
Remote Job Entry PRPQ	113
MULTI-LEAVING Remote Job Entry Work Station Program	113
Batch Work Station Utility Programs	114
The IBM System/34	114
Binary Synchronous Communications	115
MULTI-LEAVING Remote Job Entry Utility	115
SNA Remote Job Entry Utility	115
System Network Architecture	116
Remote Work Station Support	116
The IBM 5100 and 5110 Computer	118
The 5100 and 5110 Computer with Asynchronous Communications	118
The 5110 with Binary Synchronous Communications	118
The IBM 5230 Data Collection System	119
Data Collection System Support	119
On-line Data Collection and Inquiry	120

<b>APPENDIX A. GLOSSARY</b>	<b>123</b>
<b>APPENDIX B. BIBLIOGRAPHY</b>	<b>129</b>
Batch Work Station	129
Binary Synchronous Communications	129
Channel Connected Systems	130
Communications Control Program	130
Data/3	133
Multiline/Multipoint	133
Multiline Terminal Adapter	133
RPG II Telecommunications Feature	134
RPG II 3270 Display Control Feature	134
Remote Job Entry and MULTI-LEAVING Remote Job Entry	134
Terminal Query Facility	135
Terminals	135
Systems Network Architecture	137
Synchronous Data Link Control	137
<b>INDEX</b>	<b>139</b>

### WHAT IS DATA COMMUNICATIONS?

Data communications is the process of transmitting information from one location to another. When data communications is used with data processing, data might be transmitted between one or more of the following data processing devices:

- From one computer to another computer
- From a computer to a terminal
- From a terminal to a computer
- From one terminal to another terminal

A data communications system consists of the group of terminals, computers, programs, and transmission facilities that make up the system.

### WHAT ARE THE BENEFITS OF DATA COMMUNICATIONS?

The ability to transmit data from one data processing device to another can offer many benefits. For example, data may be entered directly into data files, so as to reduce the need for posting, recording, punching, or other controls. Data entered may be more accurate because it can be entered at its source by personnel who are most familiar with it. Management can then access this accurate up-to-date data to use for better control of daily business transactions.

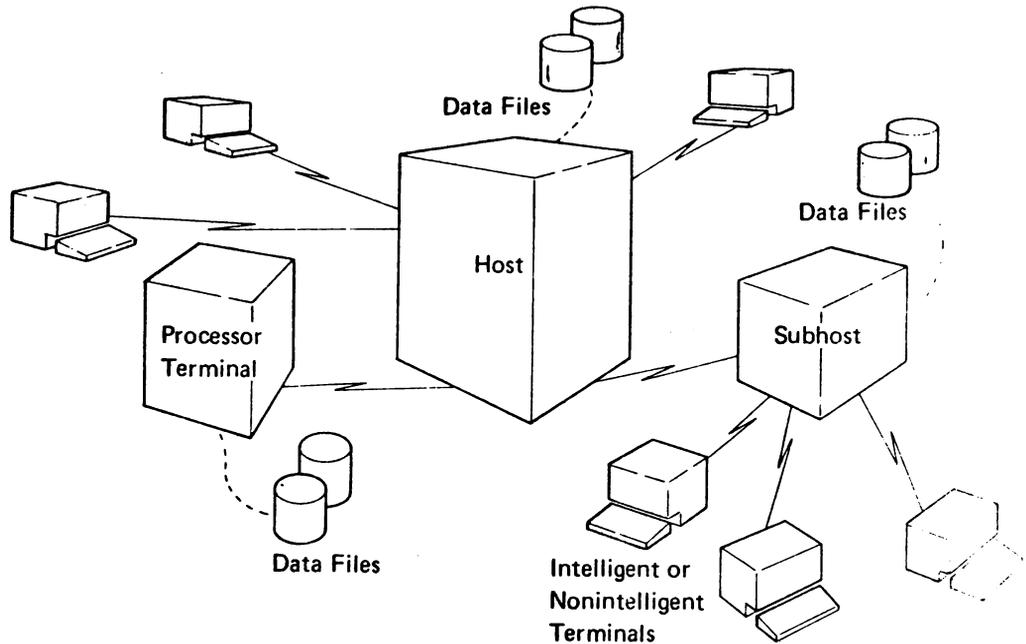
These benefits and more will be discovered as the uses of data communications are presented. The effect of these benefits, however, is improved customer service because businesses can offer fast, accurate responses to customer orders or inquiries.

### WHAT ARE THE USES OF DATA COMMUNICATIONS?

Most data processing systems currently in use perform one or more of the following functions using data communications:

- *Data entry*: Entering data directly into data files
- *Inquiry*: Searching data files for specified information
- *Record update*: Altering, adding to, or deleting data stored in files
- *Remote batch entry*: Entering batches of data from a remote location into data files
- *Remote job entry*: Transmitting data and/or processing instructions to a remote data processing system for processing

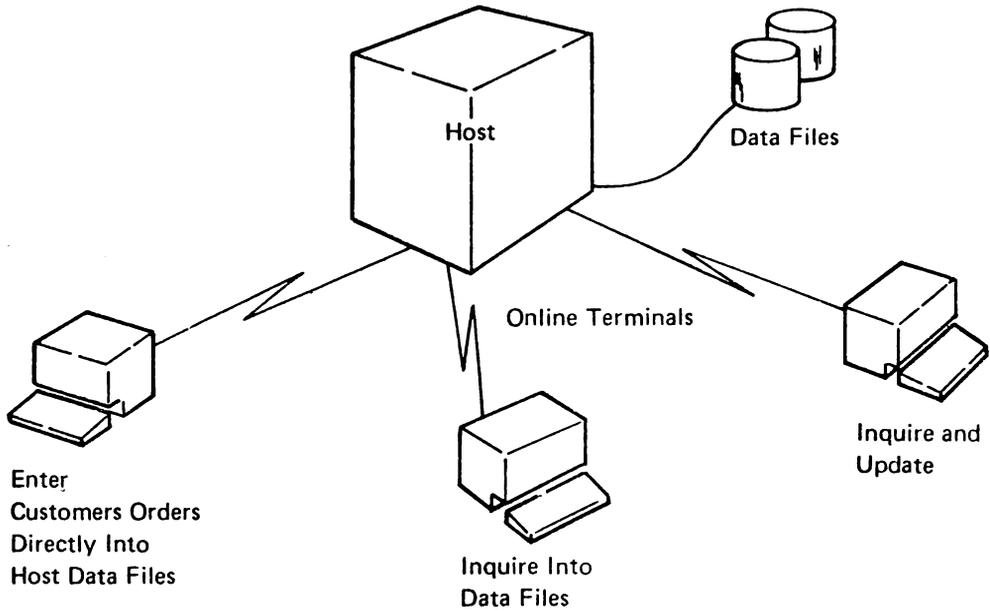
The following illustration shows the orientation of GSD data processing systems and terminals in a data communication configuration. This illustration may be helpful during the following discussion of the uses of data communications:



- The host system is the highest level system, and usually the largest system, in a data communication system configuration.
- The subhost system communicates with the host and with terminals and/or other systems.
- The processor terminal is a computer or a programmable terminal that can function as a terminal when communicating with a host, or can do other processing when not communicating with a host.
- The intelligent terminal can perform some of the functions of a host or subhost.
- The nonintelligent terminal is the input and/or output station in a data communication system configuration.

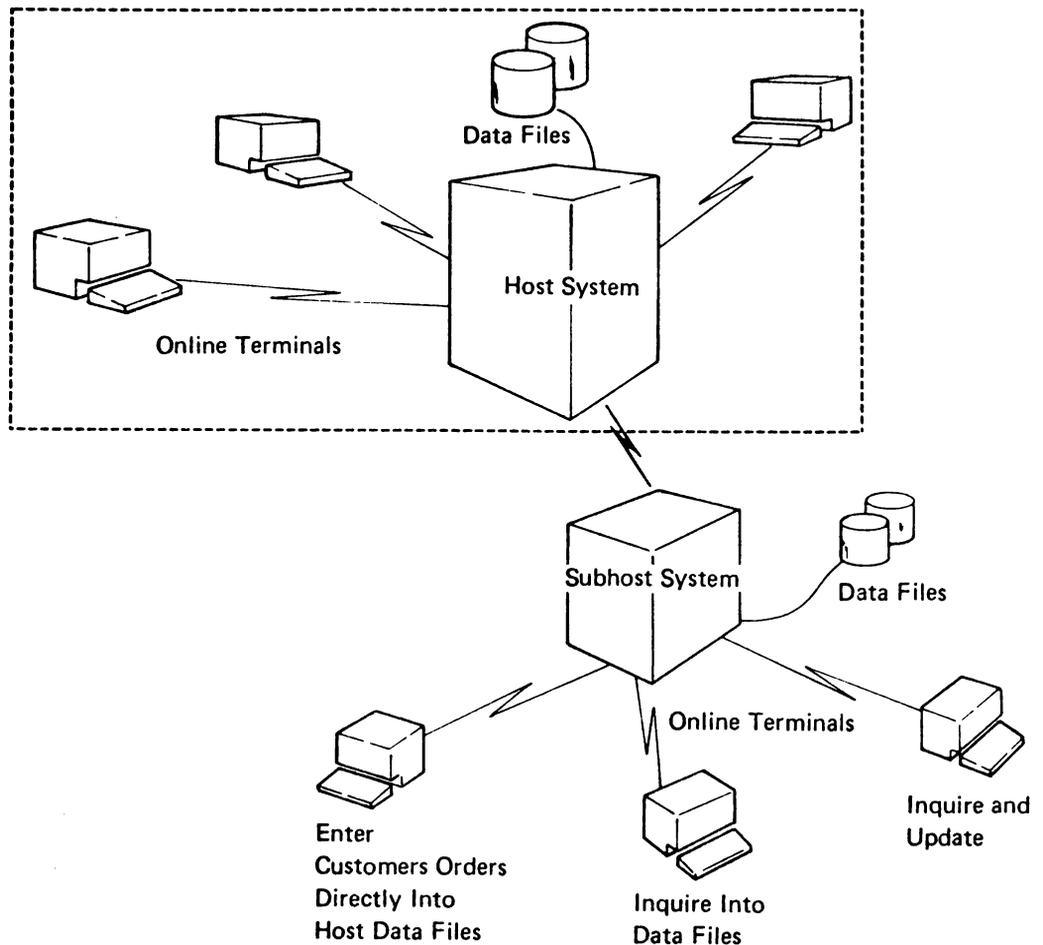
## DATA ENTRY, INQUIRY, AND RECORD UPDATE

The following example shows a host system with attached terminals. This system can be used for data entry, inquiry, and record update:



With this system, customer orders can be entered directly into host system files from a remote terminal. At the same time, other terminals can be used to inquire into and/or update host system files. This is often called real-time data processing. (Real-time data processing is data being received, processed, and ready to use immediately.)

If the host system is connected to another host in addition to the terminals, the system becomes a subhost system as shown in the following example:



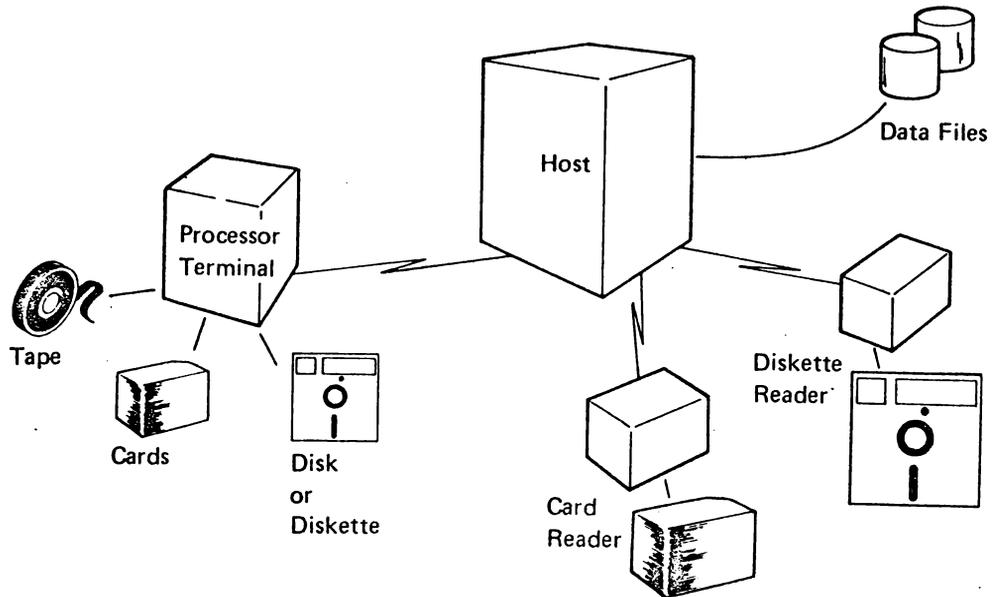
A subhost system can perform all the functions of a host and also:

- Send summary data to the host
- Receive and process data from the host
- Perform inquiries into subhost data files for the host
- Inquire into host files from the subhost itself or a subhost terminal

Using subhost systems allows some of the data that is normally transmitted to the host for processing to be processed at the subhost location.

## REMOTE BATCH ENTRY

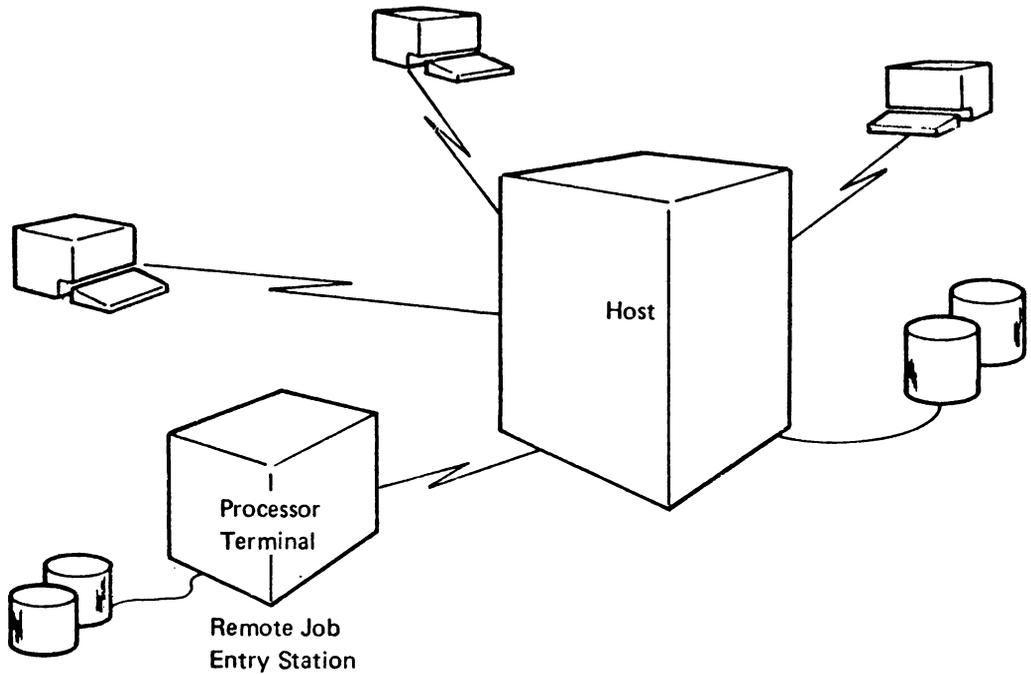
This example shows a host system as a remote batch entry system:



The host functions as a data processing system without communications while personnel enter and store data on disk, tape, or other storage media at remote locations. Then, at assigned times, the host is connected to the terminals via a communication channel to allow terminal operators to transmit the stored data to the host for processing. The terminals in this system can be nonintelligent terminals, intelligent terminals, processor terminals, or a combination of these.

## REMOTE JOB ENTRY

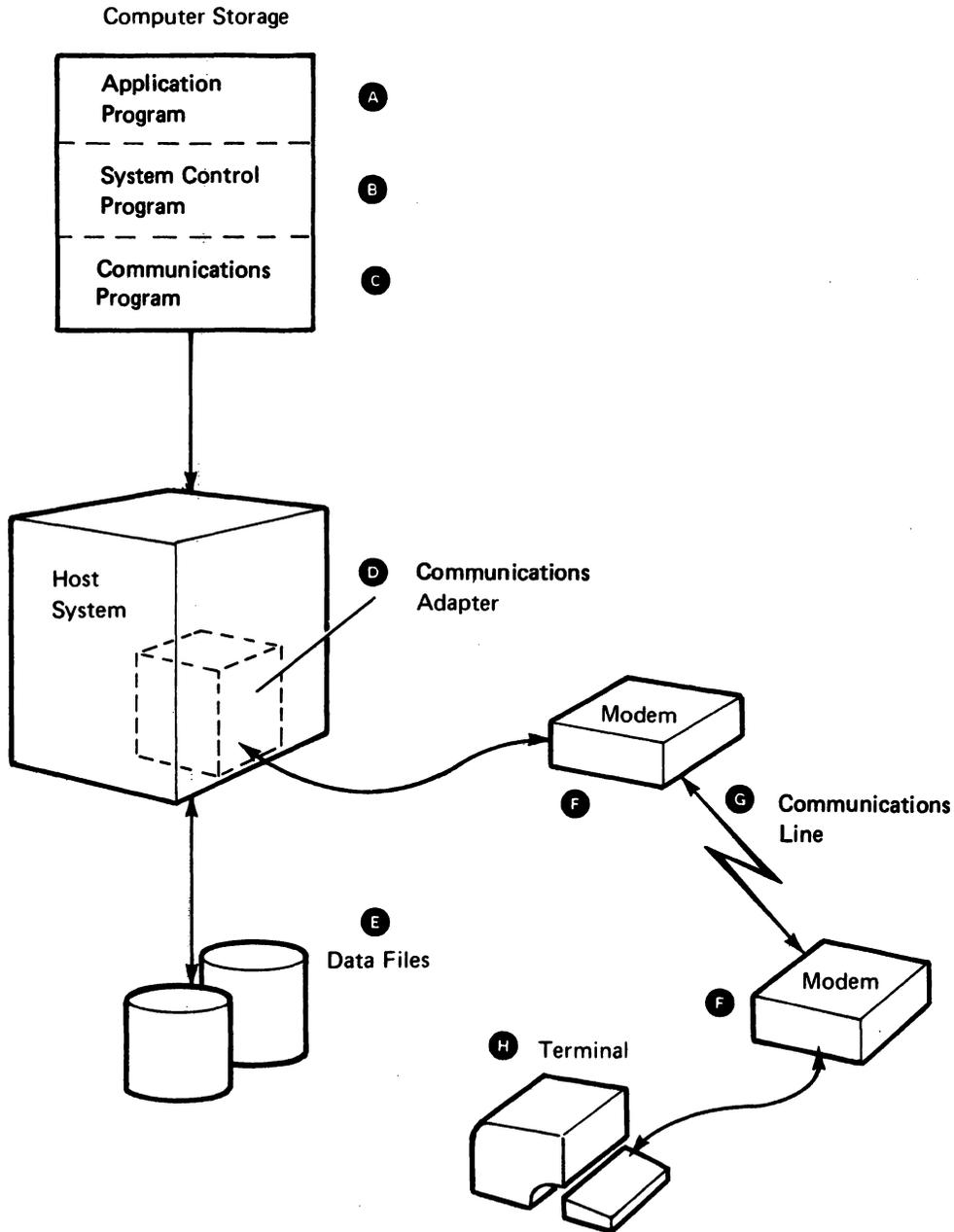
This example shows a processor terminal as a remote job entry station:



When the processor terminal is connected to the host as a remote job entry station, the user of the processor terminal can send data and/or processing instructions to a host system for processing. Thus, the processor terminal user can benefit from the processing power and storage capacity of a larger system. The results can then be transmitted back to the processor terminal to be printed and/or stored for later use, sent to another terminal, or used by the host's I/O devices. A nonintelligent terminal or an intelligent terminal can also be used as a remote job entry station.

## Chapter 2. Parts of a Data Communications System

The parts of a data communications system depend on how the system is used. There are, however, basic parts required for data communications. The following example shows a host system and a terminal in a configuration requiring all of the basic parts.



- Ⓐ Application programs are the programs that perform user jobs. With most IBM systems, application programs are written with the same programming language (such as RPG II, FORTRAN, or COBOL) the customer uses for programs that are not data communications programs.
- Ⓑ The system control program (when used) prepares the data from the application program for use by the communications program.
- Ⓒ In this configuration, the host communications program controls communications between the host and the terminal. Some systems may also use a microprocessor(s) to help control data transmission.
- Ⓓ A communications adapter connects the host system processing unit to the modem.
- Ⓔ Disk data files allow the user to store and use data.
- Ⓕ Modems convert computer signals to communications line signals at one end of the line and back to computer signals at the other end of the line. Modems may be external to or built into the host and/or terminal.

Several terms are used to describe the equipment used to convert signals transmitted over communications lines: data circuit terminating equipment, line adapter, and modem. In this manual, the word *modem* is used to describe the equipment that converts signals to be transmitted over communications lines.

- Ⓖ A communications line transmits the data from modem to modem.
- Ⓗ A display terminal is used to enter and send data to the host or to retrieve data from the host data files.

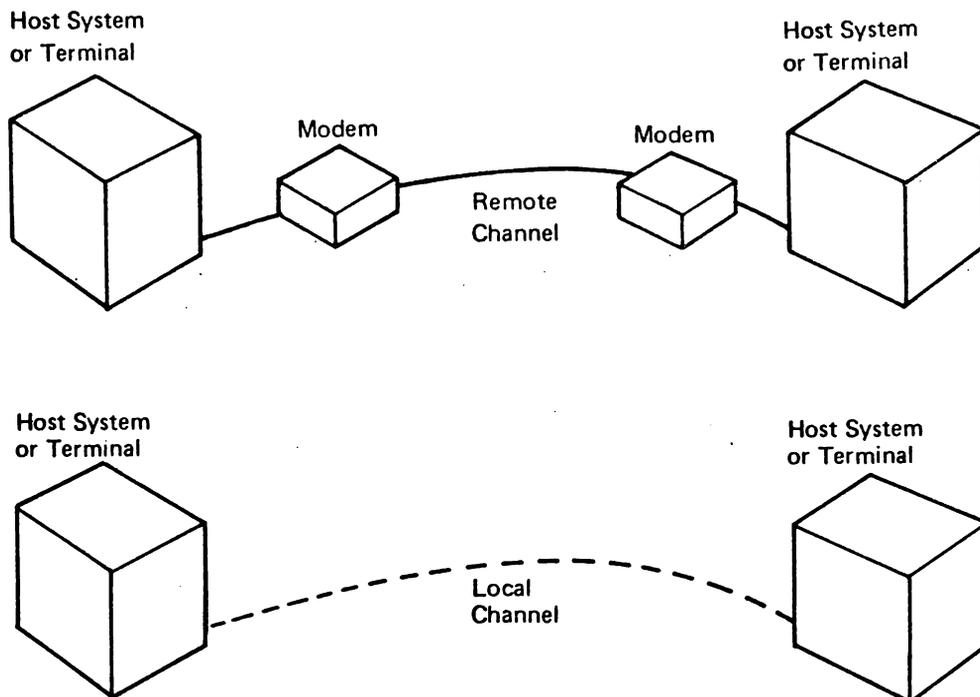
Communications adapters, lines, and modems are described in more detail in subsequent chapters.

## Chapter 3. Communication Networks

A communication network consists of the equipment that transmits data between data processing devices. Network equipment consists of transmission lines (wires or cables), satellites, microwave equipment, switching equipment, and many other devices that are used to transmit data. It is not necessary to understand how the equipment of a network functions to use a data communication system.

Most communication networks are supplied by communication common carrier companies. A communication common carrier company is one that supplies communication services to the public. For example, a telephone company is a common carrier company.

Several terms are used for the electrical path between data processing devices in a data communications configuration: communication channel, communication lines, communication facility, and communication link. In this manual, the term channel is used for the path between modems or other devices if modems are not used. Thus, the communication channel includes all of the equipment that transmits the data from one modem (remote channel) or one device to the other device (local channel) as shown:



A communication line or a communication facility is a communication channel.

**The term communication link is the physical or electrical connection to the terminal or other computer. Thus, the communication link includes the channel, modems (when used), and communication controlling portions of the terminal or other computer.**

**A communication network can consist of more than one channel. That is, a station can communicate with more than one other station via the same network. A network can also consist of a combination of switched, nonswitched, point-to-point, and multipoint channels.**

## **SWITCHED LINES**

**Switched lines (also called dial lines or dial circuits) use the same equipment and transmission lines that are used for voice (telephone) communications. Before data can be transmitted, a connection must be established between devices. To establish a communications connection between a terminal and a host and to exchange information on a switched line, the following usually occurs via switching equipment in common carrier exchange offices:**

- 1. The host system dials the call automatically (if the host supports an Automatic Calling feature), or the terminal operator manually dials the number of the host system location.**
- 2. The host system automatically answers the call and establishes a communications connection (if the host is equipped with an Automatic Answering feature) or an operator at the host answers the call and establishes the connection.**
- 3. The terminal operator then enters a sign-on code using the terminal keyboard to identify the terminal to the host.**
- 4. When the host receives the sign-on code, it is checked for correct identification, and the host makes the appropriate response.**
- 5. If the sign-on code is correct and is recognized by the host, the terminal operator can exchange information with the host.**
- 6. The terminal operator signs off and disconnects the communications connection when the information exchange is complete.**

## **NONSWITCHED LINES**

**Unlike switched lines, nonswitched lines (sometimes called leased or private lines) do not require dialing to establish a communications connection. The line is permanently connected and always available. Nonswitched lines often use the same network equipment as switched lines. They might even be routed through common carrier exchange offices; however, they are permanently connected instead of being routed through switching equipment.**

**Nonswitched lines that you own and maintain are called customer-owned lines. For example, if you connect several terminals to a host, and the terminals are located in the same building or a building nearby, you may install your own wires or cables and equipment to connect the terminals to the host system. Because these are your own lines, you do not need the services of a common carrier.**

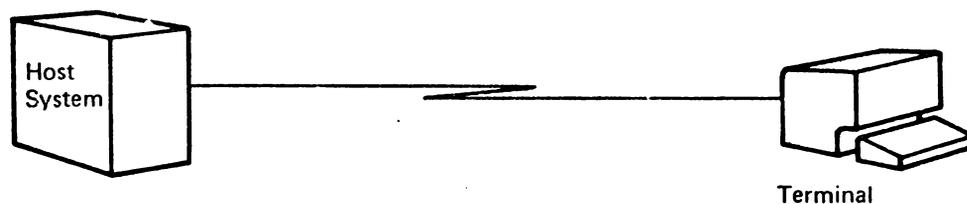
## SWITCHED VERSUS NONSWITCHED

Whether to use switched or nonswitched channels depends on the system configuration and how you are using the system. The following should be considered when determining whether to use switched or nonswitched channels:

- With a switched channel, you can dial practically any terminal or host location. With automatic dialing and/or automatic answering equipment, dialing and answering can be accomplished automatically under program control.
- With a switched channel, you are charged for long distance calls according to the time you use the channel. This could be an advantage if you have a low volume of transactions on long distance channels. For example, you could store data on tape, disk, or another storage media and transmit it all at once when the rates are lowest.
- Nonswitched channels (common carrier owned) have a fixed monthly rate. This could be an advantage if you have a large volume of transactions, such as an application that requires repeated inquiries or updates of files, and the channel must be connected for long periods.
- Nonswitched channels can be conditioned for data transmission to reduce transmission errors and increase the speed capability of the channel.
- Nonswitched channels might provide greater data security since you are the only one using the channel.

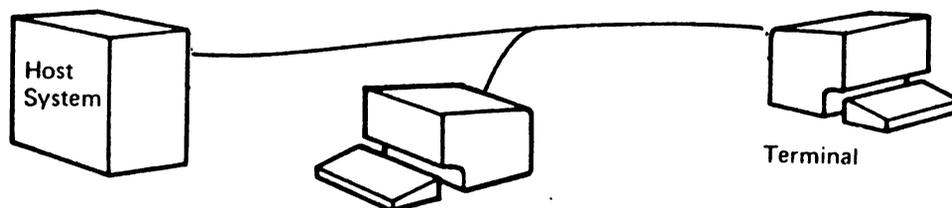
## POINT-TO-POINT AND MULTIPOINT

When a channel is connected between only two stations as shown in the following example, it is a point-to-point channel:



A point-to-point channel can be either switched or nonswitched.

When a channel is connected between two or more stations as shown in the following example, it is a multipoint channel:

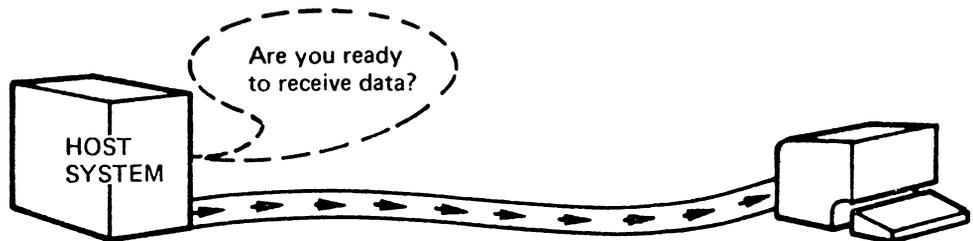


There are now three stations on the one channel, a host and two terminals.

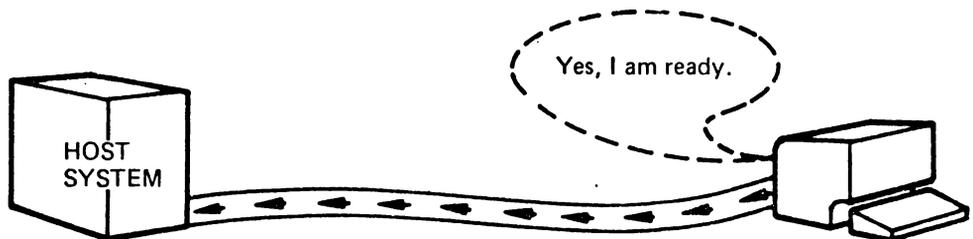
## Controlling the Devices on a Point-to-Point Channel

Because a point-to-point channel has only two devices on it, it is the easiest channel on which to control communications. Communications between stations is normally controlled as shown in the following example of point-to-point channel connecting a host and a terminal:

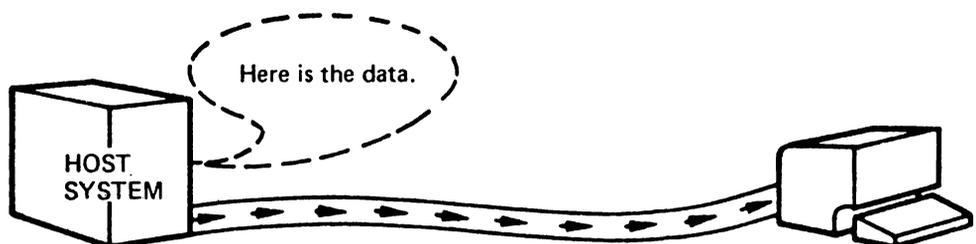
1. The host first checks the terminal to determine if it is ready to receive data (also called a bid for the channel):



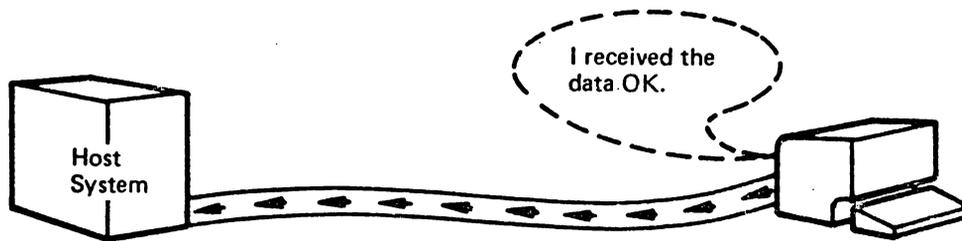
2. If the terminal is ready to receive, it acknowledges (responds) by indicating its status to the host. For example, a terminal that is a printer might indicate that it is turned on, that it contains paper, and that it is ready to receive data:



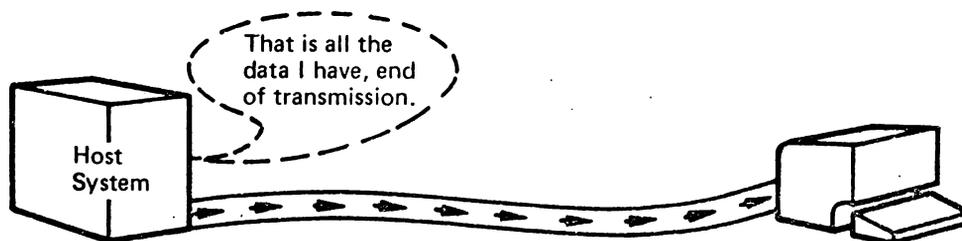
3. Upon receiving the acknowledgment, the host normally indicates an error if the acknowledgment is negative. The host also indicates an error if the terminal did not respond. If the acknowledgment is positive, the host sends the data:



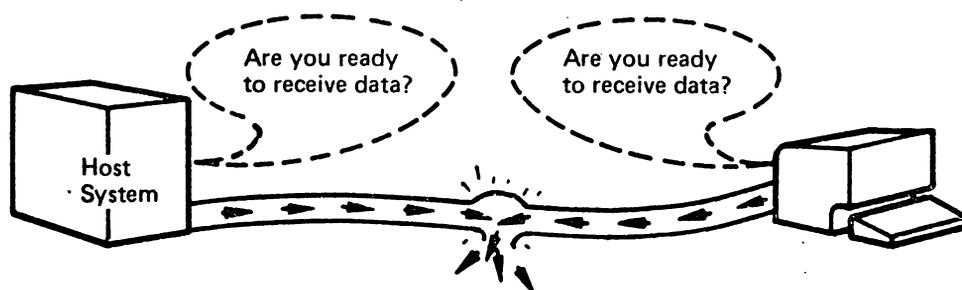
4. If the terminal receives the data correctly, it normally sends a positive acknowledgment back to the host:



5. The host may then send more data or indicate the end of transmission.



Either station on a point-to-point channel may initiate communications (bid for the channel); therefore, both stations could bid at the same time:



This is called contention. Both the host and the terminal would receive a negative acknowledgment or no response to their request.

There are different methods used to resolve contention. For example, one method is to assign one station as a primary station and the other as a secondary station. A primary station is designed to always gain control of the channel first. The secondary station must then wait to send its data until the primary station indicates that it is finished transmitting.

## Controlling the Devices on a Multipoint Channel

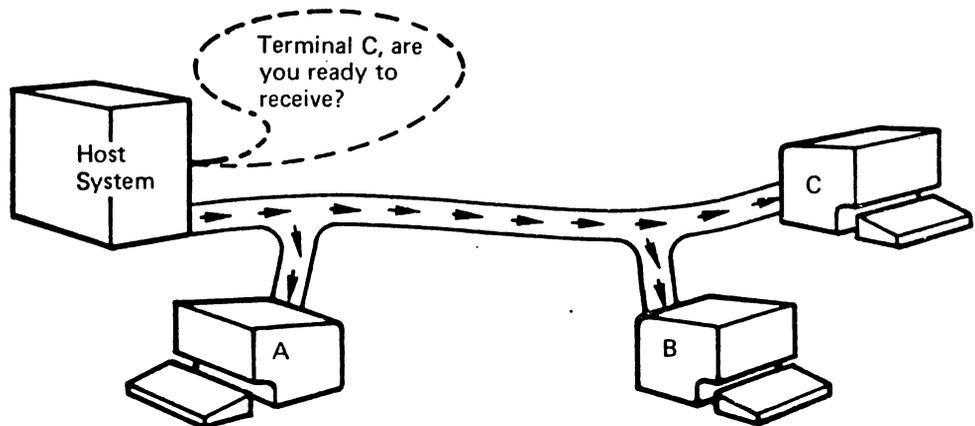
Controlling communications on a multipoint channel is more complicated since there is more than one terminal on the channel. On a multipoint channel, one station is designated as the control station and all other stations are tributaries. The control station controls communications by addressing and polling.

### Addressing

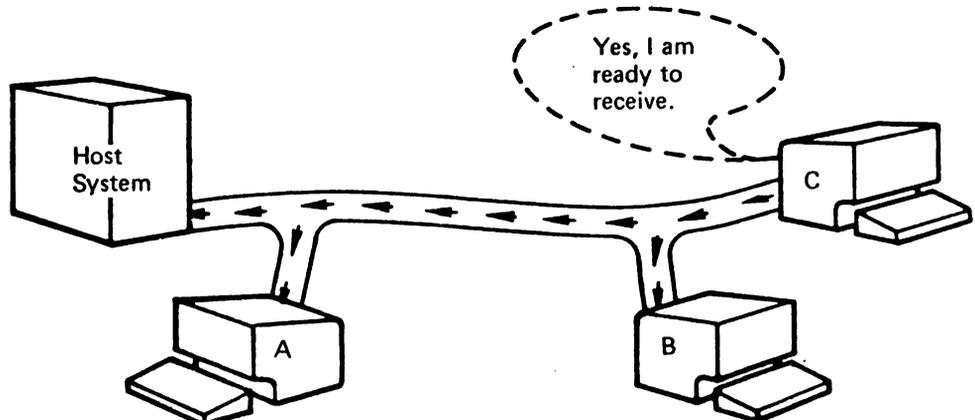
When the control station sends data to a tributary station on a multipoint channel, the data is available to all tributary stations on the channel. Therefore, each transmission must be controlled so that the correct station receives the data. Thus, each station is assigned an address, such as A, B, and C. The control station selects the correct tributary station by sending the address of that station before sending the data. This is called addressing or selection. Once the station is selected and ready to receive data, the control station sends the data on the channel, and, though the data is available to all tributary stations, only the station that is selected receives it.

The following example of a host system (control station) and attached terminals (tributary stations) shows how a host addresses and sends data to terminals on a multipoint channel.

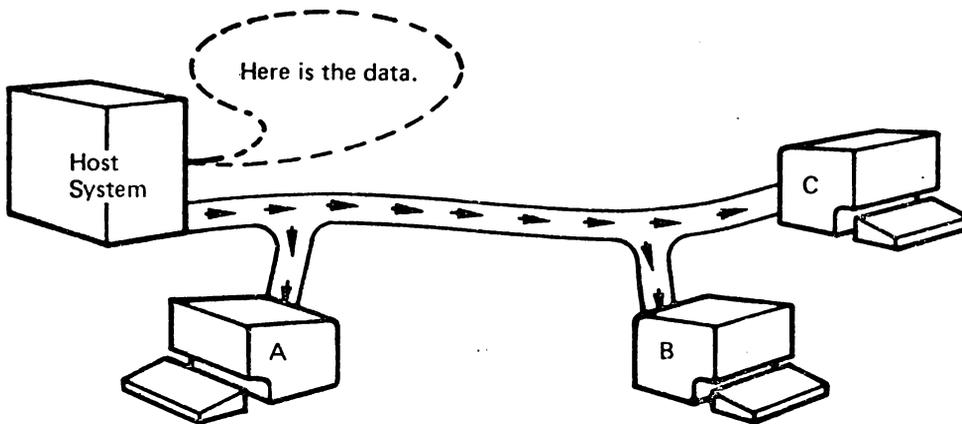
1. To send data to a terminal, the host first selects the correct terminal (in this example, terminal C) by sending the address of that terminal:



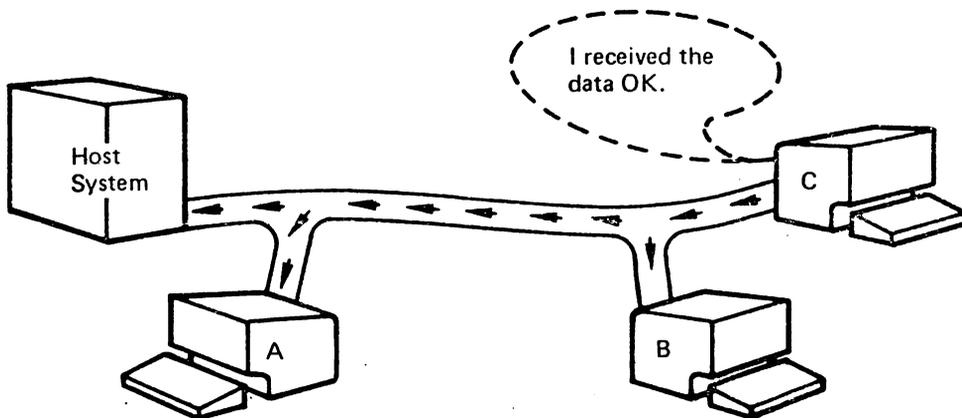
2. Only terminal C responds to the address sent by the host (the other terminals on the channel receive the address sent by the host and the response sent by terminal C but ignore both):



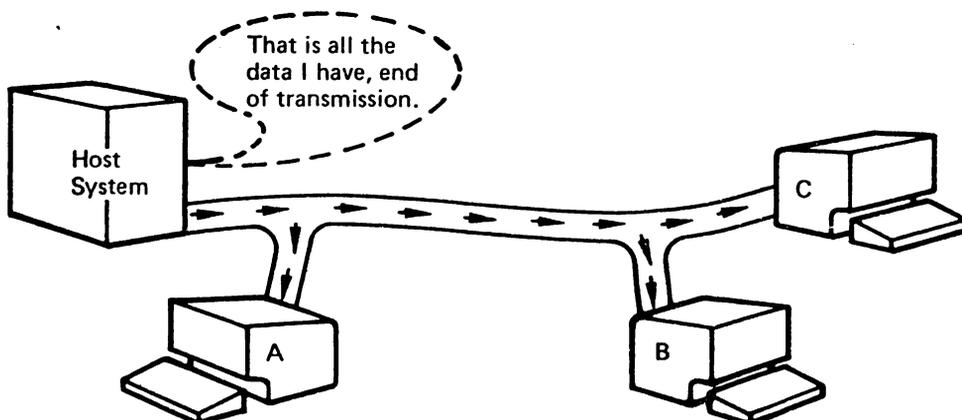
3. Having acknowledged, terminal C is now ready to receive data. The host can send the data and only terminal C processes it (terminals A and B ignore the data):



4. Terminal C also acknowledges after receiving the data (terminals A and B ignore the response):



5. The host then sends more data, or indicates the end of transmission (the end of transmission indicates that terminal C is no longer selected and the channel is now available):

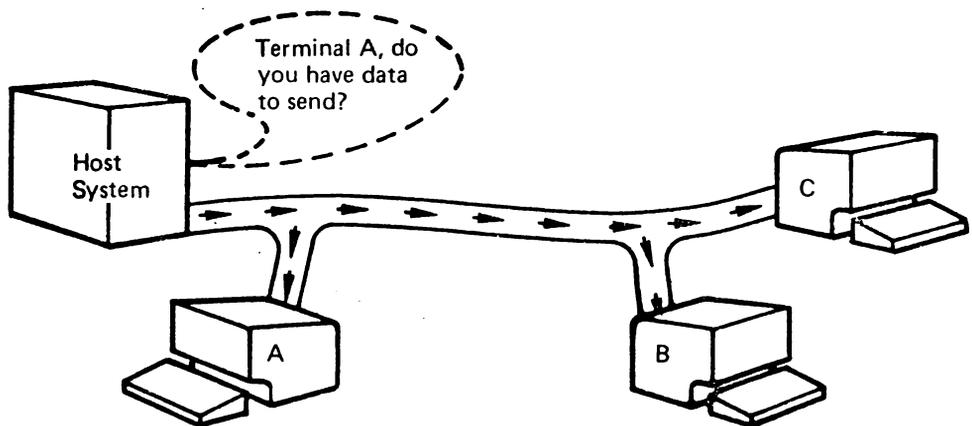


## Polling

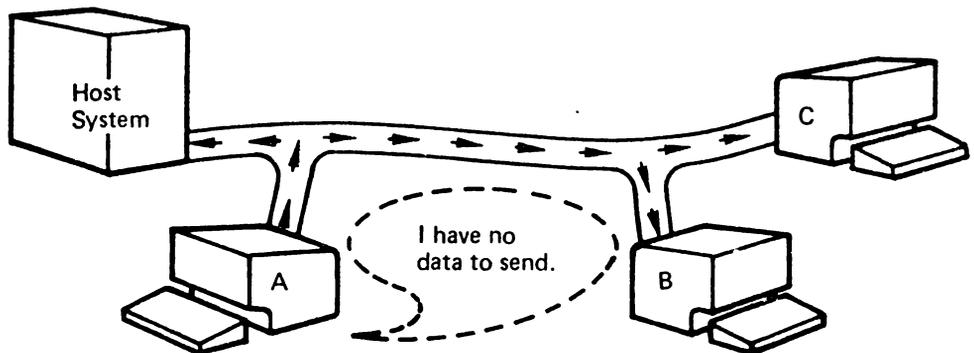
The control station must also control when each tributary station transmits data. If all tributary stations began sending at the same time, it would be impossible to determine which station was transmitting. Since each station has an address, the control station can send the address of each tributary station, one at a time, to determine if any of them have data to send. This is called polling.

The following example of a host and attached terminals shows how a control station polls tributary stations on a multipoint channel.

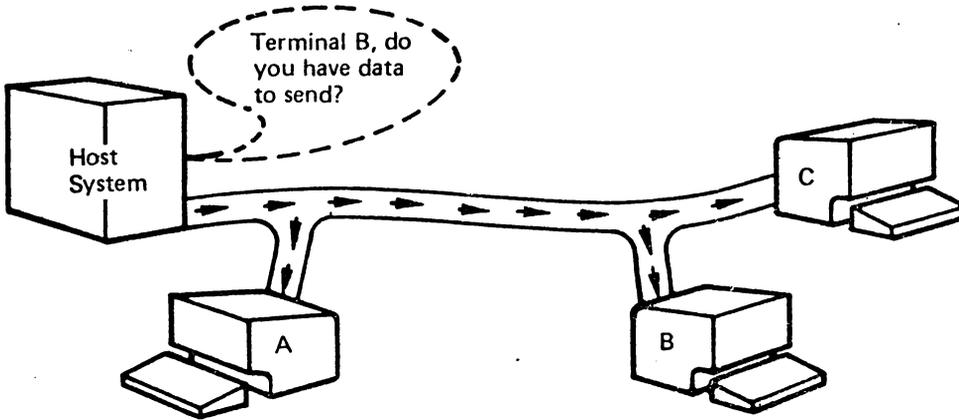
1. The host polls each terminal, one at a time, starting with terminal A:



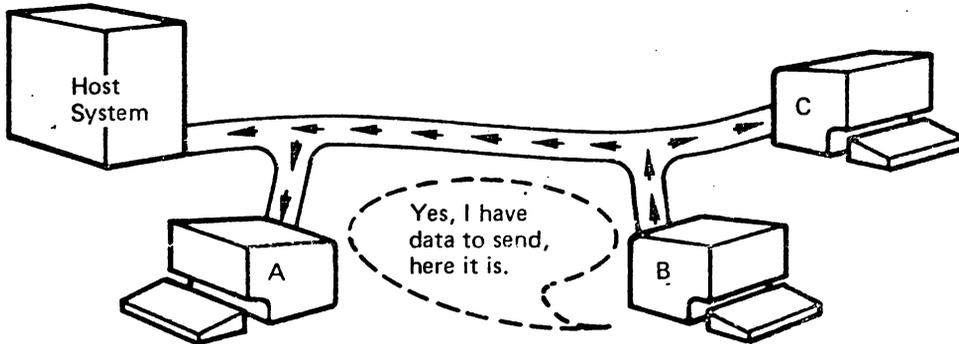
2. Although all terminals on the channel receive the address for terminal A, only terminal A responds (terminals B and C receive the response but ignore it):



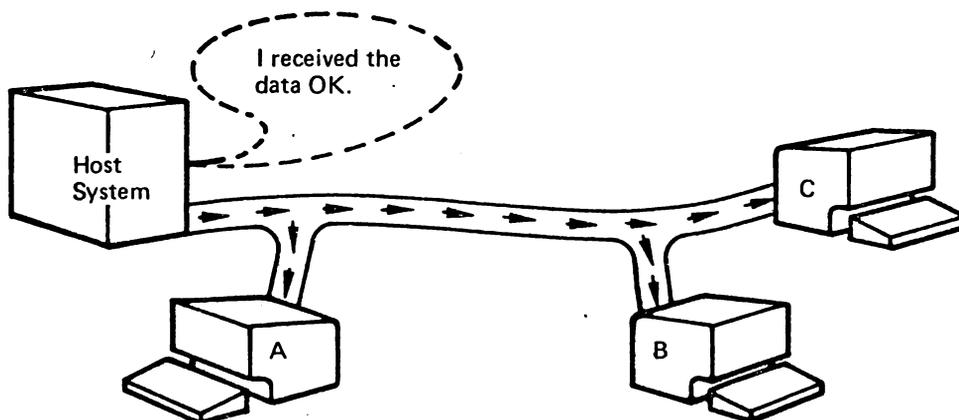
3. After receiving the response from terminal A, the host polls terminal B:



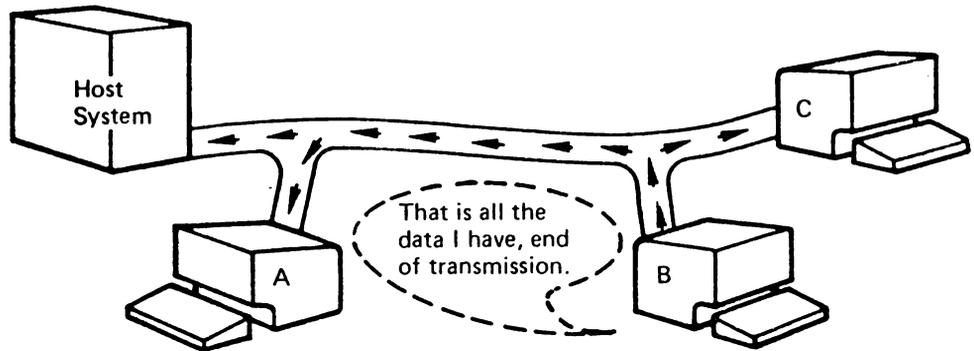
4. This time only terminal B responds. Assume terminal B is ready and has a message for the host (terminals A and C ignore the data and the response):



5. The host responds to terminal B to indicate that the data was received OK (terminals A and C ignore the response):



6. Terminal B may send more data or indicate the end of transmission (the end of transmission indicates that terminal B has completed its transmission and the channel is now available):



Terminals do not have to be polled in sequence. A polling list can usually be set up for the most efficient operation. If a terminal is seldom used, it does not have to be polled as often as a more active terminal. For example:

A B A B A B C A B . . .

Polling the seldom-used terminal less often uses system time more efficiently.

## TIMEOUTS

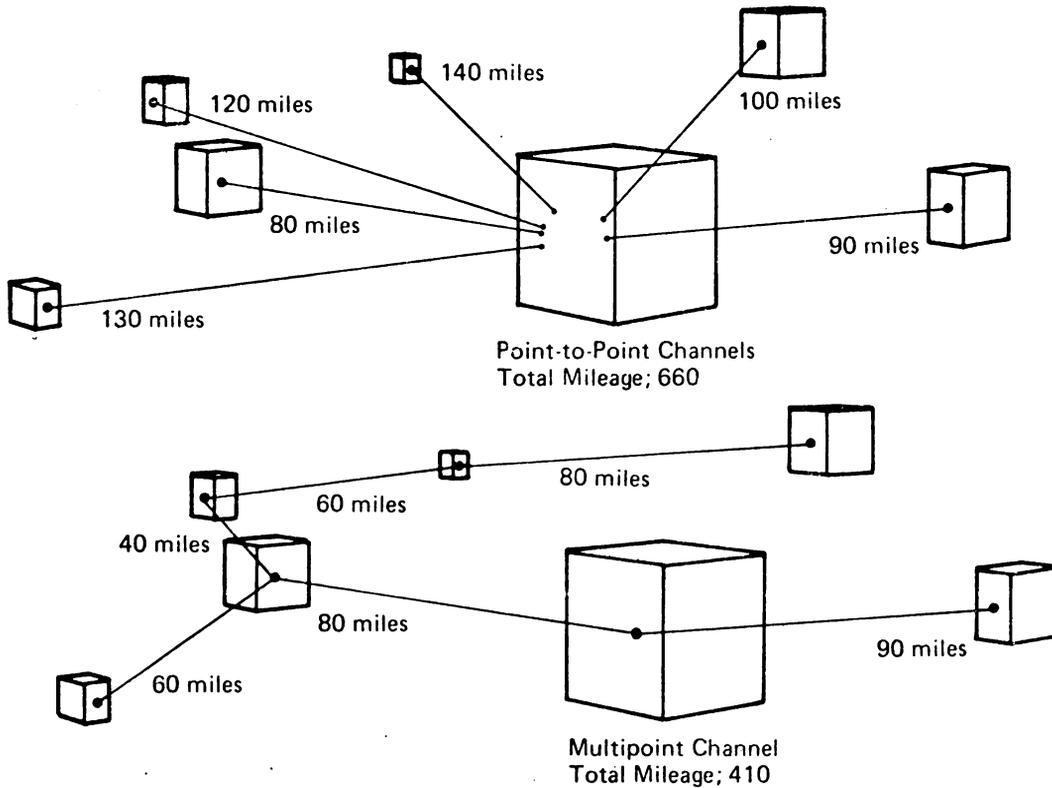
Another situation that must be controlled is a station failing to acknowledge a request (on either a switched or a nonswitched channel). For example, a station that is not powered on could not acknowledge a request from another station. Rather than have a station wait for the response for an indefinite time and, thus, tie up the channel so that other stations can not communicate, the requesting station normally waits a short time, then retries the request or goes on to another station or another job. This wait is called a timeout.

Timeouts can vary from one second to several minutes, depending on the station and whether it is receiving or transmitting. Some timeouts are automatic hardware functions and some are program functions.

## POINT-TO-POINT VERSUS MULTIPOINT

If controlling a point-to-point channel is easier, why not use point-to-point channels? The answer to that question involves how the rates (called tariffs) are computed for nonswitched channels.

Common carrier companies generally charge for a nonswitched channel by the length of the channel in air miles. The following example shows the mileage of a network of nonswitched point-to-point channels as compared to the mileage of a network consisting of one multipoint channel (both networks use the same host and terminals):

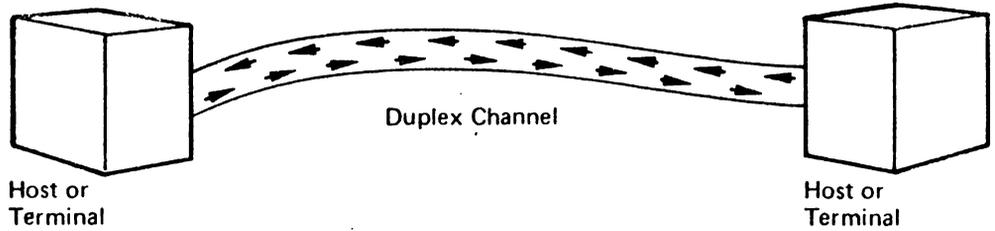


The example shows that the total channel miles in the network with the multipoint channel is shorter than the total channel miles in the network with the point-to-point channels. Thus, the multipoint network charges are less than the point-to-point network charges. Also, a modem is required at each end of a nonswitched point-to-point channel. In the point-to-point example, six modems are required at the host system. In the multipoint example, only one modem is required at the host system. (Switched point-to-point channels may also use one modem at the host system.)

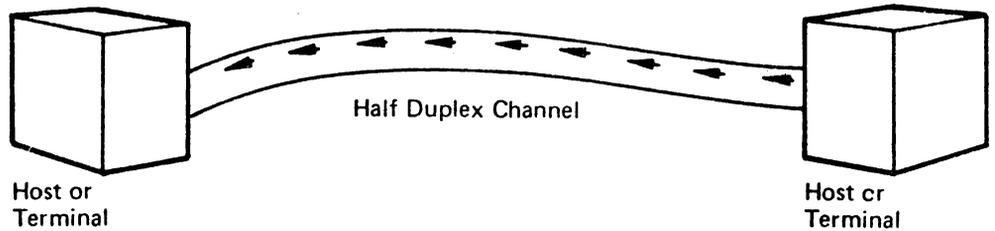
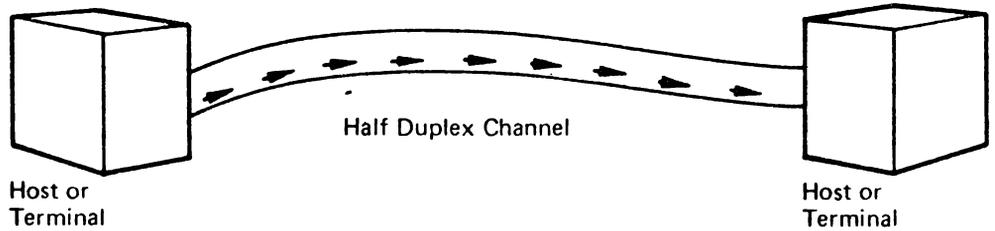
Another item that may affect the rates is whether the channel is intrastate or interstate. When the channel is an intrastate channel, the rates are controlled by that state's Public Utility Commission. Therefore, intrastate rates may vary from state to state. When the channel is an interstate channel, the rates are controlled by the Federal Communications Commission. Therefore, interstate rates are usually the same throughout the United States.

## DUPLEX AND HALF DUPLEX

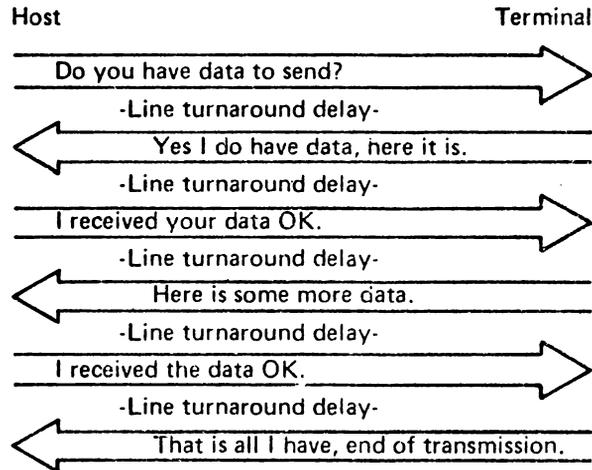
Duplex (or full duplex) transmission is data transmission in both directions simultaneously. A duplex channel, as shown in the following example, can transmit data in both directions simultaneously:



Half duplex transmission is data transmission in both directions but not simultaneously. A half duplex channel, as shown in the following example, can transmit data in both directions but not simultaneously:



Most stations, presently in use, are not capable of duplex transmission; however, even if a station cannot transmit and receive simultaneously, there is an advantage in using duplex channels. The advantage is a reduction in line turnaround time. When a station changes from transmit to receive or from receive to transmit, there is a delay called line turnaround time. This delay is necessary to allow modems and network equipment to switch the direction of transmission and to assure that all data has reached its destination. Messages that require frequent line turnarounds can cause a significant delay. The following example shows how line turnaround time can affect transmission:



If a duplex channel is used, the modems and network equipment are always ready to transmit and receive and the line turnaround delay is minimal.

## TRANSMITTING THE DATA

In data communications, several code structures are used to assign the combinations of bits (1's and 0's) to data characters. The most common code structures used are the EBCD (extended binary coded decimal), EBCDIC (extended binary coded decimal interchange code) and the ASCII (American standard code for information interchange) codes. All devices on the channel must use the same code structure. For example, if a host is using the EBCDIC code structure, then all terminals or other systems that the host communicates with must also use the EBCDIC code structure.

Most stations transmit data serially, one bit at a time, over the communication channel. The speed that the bits are transmitted is specified in bits per second (bps) or bauds. (Baud indicates the number of discrete signal changes per second on a channel and does not always equal bits per second.)

Data communications channels are classified by maximum transmission speed and amount of channel conditioning (adding electrical or electronic components or devices to improve the data signal). All equipment must operate at the same transmission speed. For example, if a host operates at 9,600 bps, then the modems, channels, terminals, or other hosts must also operate at 9,600 bps. Conditioning may be necessary to obtain the desired transmission speed.

## **Data Validity**

Communication channels are subject to noise and interference which can alter data bits so that the receiving station may not recognize the bits. In addition, the receiving station might accept noise impulses as data bits. If a bit is changed in a character, that character and possibly adjacent characters will not be valid. Therefore, the data is usually checked for lost or gained bits.

There are three common methods to check data validity. They are VRC (vertical redundancy checking), LRC (longitudinal redundancy checking), and CRC (cyclic redundancy checking).

VRC checks each character for an odd or even number of 1 bits. For example, if the transmitting station assures that every character transmitted has an even number of 1 bits, then the receiving station must receive an even number of 1 bits for each character or the character is invalid.

LRC uses each character of data to form a check character at both the transmitting and the receiving stations. At the end of each transmission, the transmitting station sends its check character to the receiving station where the two check characters are compared. If they are equal, the data is assumed to be valid.

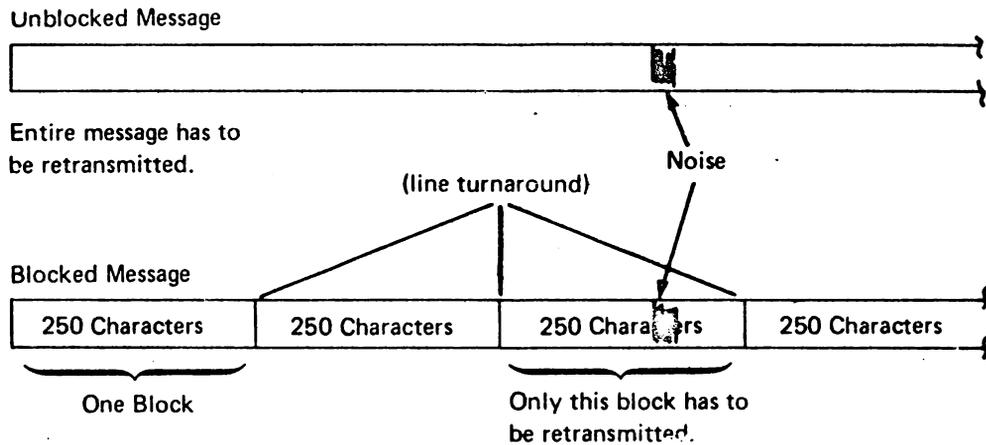
CRC uses a mathematical algorithm to form a check sequence (usually 16 bits) using all bits of all characters in a group of data. The check sequence bits are usually referred to as block check characters (BCC), which are formed at both the transmitting and receiving stations. The transmitting station sends its block check characters to the receiving station where they are compared to the block check characters formed at the receiving station. If they are equal, the data is assumed to be correct.

These error checking methods are automatic hardware or software functions. Both the transmitting station and the receiving station must use the same error checking methods. A station normally uses either CRC, VRC, LRC, or VRC and LRC in combination.

## Transmission Efficiency

When an error is detected, the receiving station normally sends a negative acknowledgment to the transmitting station. The transmitting station then usually resends the data. The longer the message is, the greater the possibility of an error occurring. Thus, a long message may have to be retransmitted several times before it is received correctly. This can greatly reduce transmission efficiency.

One method of improving transmission efficiency, is to divide the message into blocks of data as shown below:



In this example, the transmitting station sending a blocked message only has to resend 250 characters instead of the entire message. The block size used depends on how the data communication system is used, on the transmission speed, and on the condition of the channel.

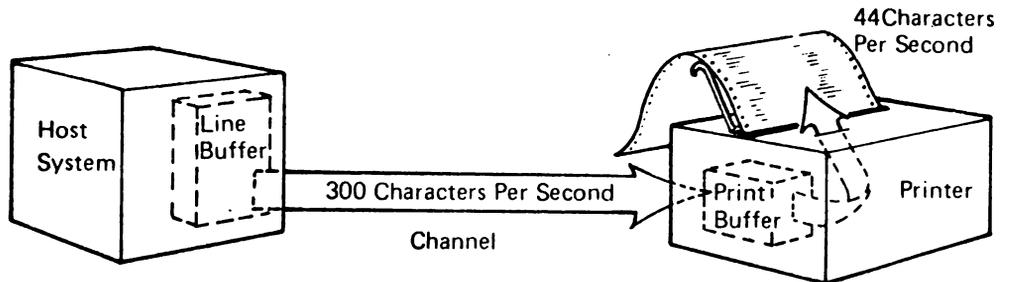
Sending data in blocks may increase the number of line turnarounds which increases the time it takes to transmit the message. If possible, different block lengths should be tried to determine which block size is the most efficient. (Some devices specify a fixed or a maximum block size.)

Because signal distortion often decreases as the transmission speed is decreased, another possible method of increasing transmission efficiency is to reduce transmission speed.

## Buffers

A buffer is a portion of computer or terminal storage that is used to store data temporarily to compensate for a difference in time or rate when data is transmitted from one device to another. In data communications, a buffer allows the data to be transmitted at the speed of the channel instead of the speed of an input or output device.

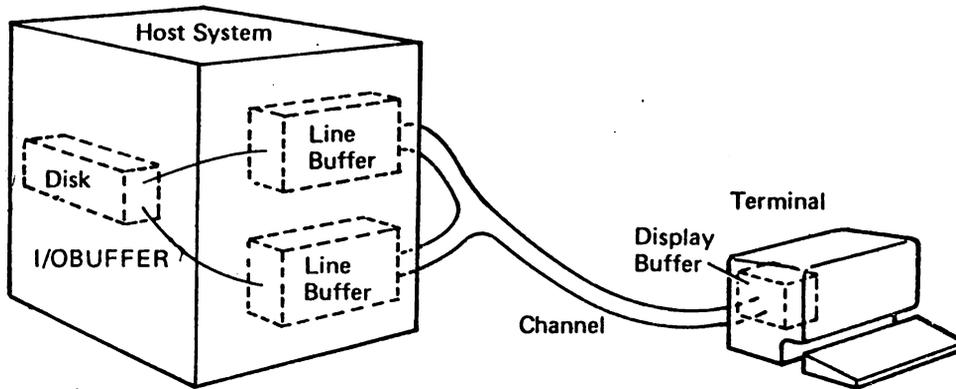
For example, suppose you are transmitting data to a 44-character-per-second printer on a channel that can transmit data at 2,400 bps (300 characters per second using an 8-bit code, such as EBCDIC). Since the printer can only print 44 characters per second, the full capability of the channel is not used. However, suppose the printer has a buffer:



The data can be stored in the print buffer at channel speed (300 characters per second) then printed at printer speed (44 characters per second).

The previous example showed the terminal receiving the data. A buffer can be used in the same manner when a terminal transmits data; for example, to transmit data that is being read from a card reader or keyboard. Data can be read from cards or entered from the keyboard into the buffer at reader or keyboard speed, then transmitted from the buffer at channel speed.

Double buffering (using two buffers) further increases the efficiency of data transmission. The following illustration shows how double buffering is used:



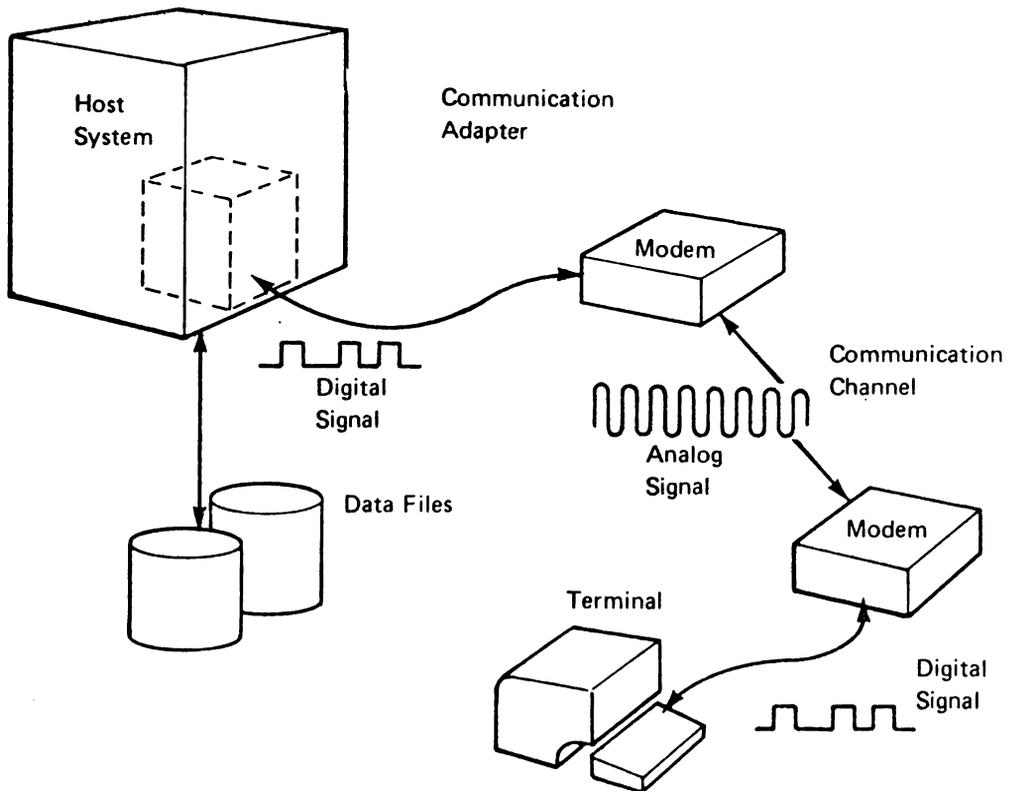
Two line buffers are used to store data that is going to the channel or being received from the channel. During a transmit operation, data can be transmitted from one line buffer while data to be transmitted next is placed in the other line buffer. During a receive operation, data from the channel can be stored in one line buffer while previously received data, stored in the other line buffer, is processed.

Buffers are also used to store data coming from or going to I/O devices (I/O buffer) as shown in the preceding example.

Buffers are fixed hardware storage, fixed software controlled storage, or software storage that is assigned and controlled by communication programs.

## Modems

Most communication channels are not designed to transmit computer signals, which are called digital signals. They are designed to transmit voice signals, which are called analog signals. The digital signals must be converted to analog signals before they can be transmitted on a communication channel that is designed for voice communications. A modem (modulator-demodulator) is a device that converts digital signals to analog signals, then transmits the analog signals to another modem via a communication channel. The receiving modem converts the analog signals back to digital signals. This is shown in the following example:



Modems may also be called data sets, data pumps, or line adapters, and they can be external to, or enclosed in (integrated modems) a computer or terminal. There are a variety of modems available, some of which perform functions in addition to signal conversion. Some of the additional functions (usually optional) that are available with modems are:

- Answering calls automatically on switched channels
- Using a switched channel if the nonswitched channel is not functioning properly (called switched network backup)
- Selecting a lower transmission speed during periods of channel interference
- Isolating problems to the terminal, modem, or channel by using built-in diagnostics

Both the modem at the transmitting station and the modem at the receiving station must be compatible. Your IBM marketing representative can assist you in selecting the proper modem.

## Chapter 4. Synchronization and Data Link Control

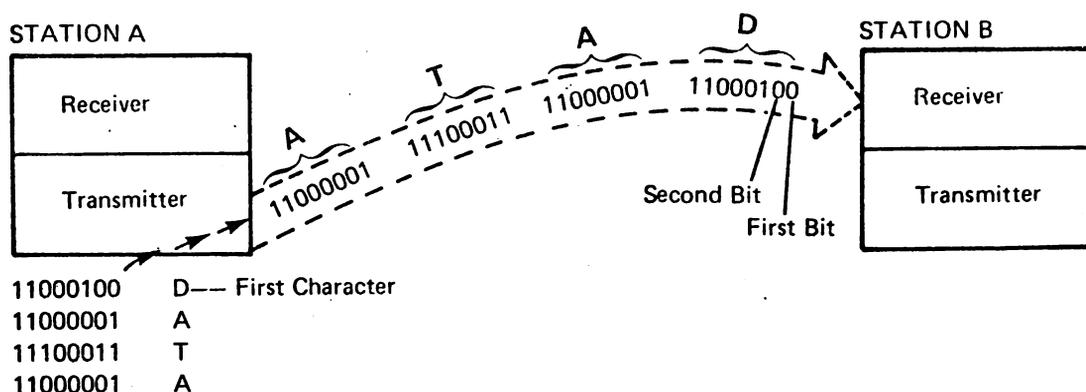
Synchronization simply means keeping the transmitting and receiving stations in step or in time with each other.

Each station, or the modem at each station, has an electronic timer called a clock. This clock times the data transmission. When the clock is in the computer, it is called business machine or internal clocking, and when the clock is in the modem, it is called modem or external clocking. The clock at the transmitting station must be synchronized with the clock at the receiving station so the receiving station can recognize the bits from the transmitting station in the same pattern that they were sent.

Data link control simply means controlling communications between two stations. Data link control is accomplished by sending control characters along with the data. The control characters indicate controls such as the beginning of a message, the end of a message, or the end of a block of data.

The methods used to synchronize and control communications between the transmitting station and the receiving station are asynchronous (also called start-stop), binary synchronous (also called BSC or bisync), and synchronous data link control (also called SDLC).

The following example shows why synchronization and data link control are needed. If data is being transmitted using the EBCDIC code structure, a series of bits representing the word DATA is transmitted as follows:



The transmitting station converts the characters into bits and transmits them to the receiving station sequentially. The receiving station must reassemble the bits into characters so the data is usable. If the receiving station begins with the first bit transmitted, and counts every eight bits as a character, everything is fine. However, the receiving station must know which bit is first. For example, if it started counting with the second bit transmitted as shown in the preceding example, the receiving station would decode the bits as something other than DATA, or indicate an error.

This is why the stations must be synchronized with each other.

Once the stations are synchronized, the receiving station can recognize the characters from the transmitting station and perform the functions indicated by the data link control characters.

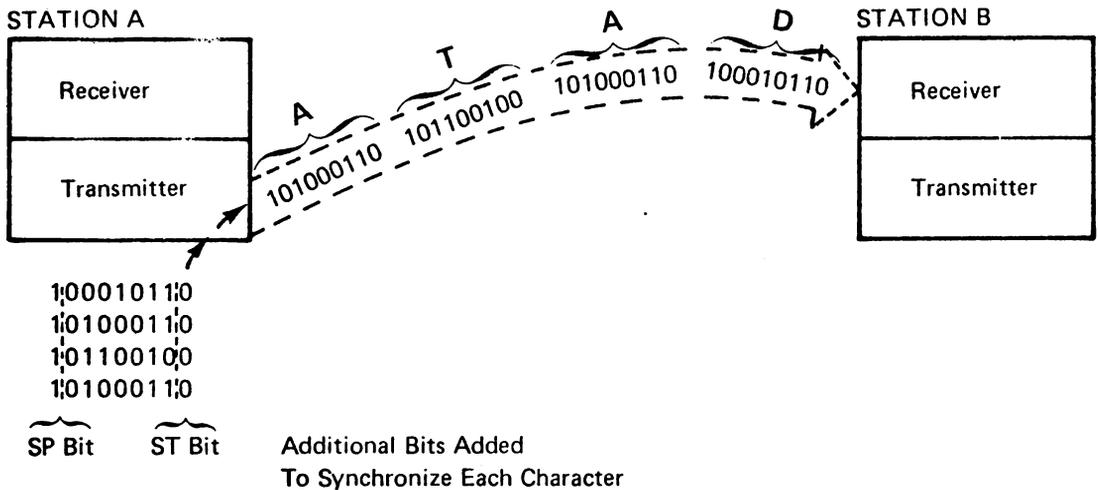
Except for unique situations, data link control characters are added to and removed from the data by hardware or by programs that are provided by IBM. If you are an application programmer, however, there may be situations that require a knowledge of the general function and sequence of data link control characters to write an efficient program. For example, your program may have to test indicators that are turned on when certain control characters are received, then perform operations based on those indicators.

## ASYNCHRONOUS

With asynchronous control, the data characters are separated, and each character is synchronized individually. For example, suppose the following series of bits are transmitted using the EBCD code structure:

```
0001011  D
0100011  A
0110010  T
0100011  A
```

Additional bits are added to each character as shown:



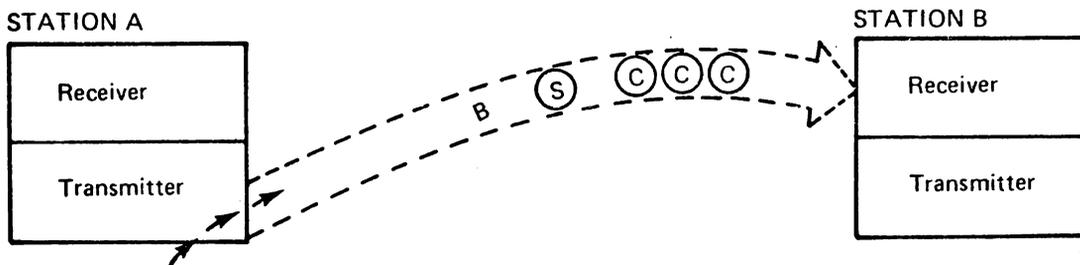
The 0 bit in the beginning of each character is called a start (ST) bit. The 1 bit at the end is called a stop (SP) bit. The receiving station recognizes these additional bits as the beginning and end of each character. The start and stop bits of each character keep the clocks in sync for that character.

Since each character is synchronized individually, the characters need not be contiguous on the channel. A series of 1-bits (called mark hold) are transmitted between characters when the characters are not contiguous on the channel.

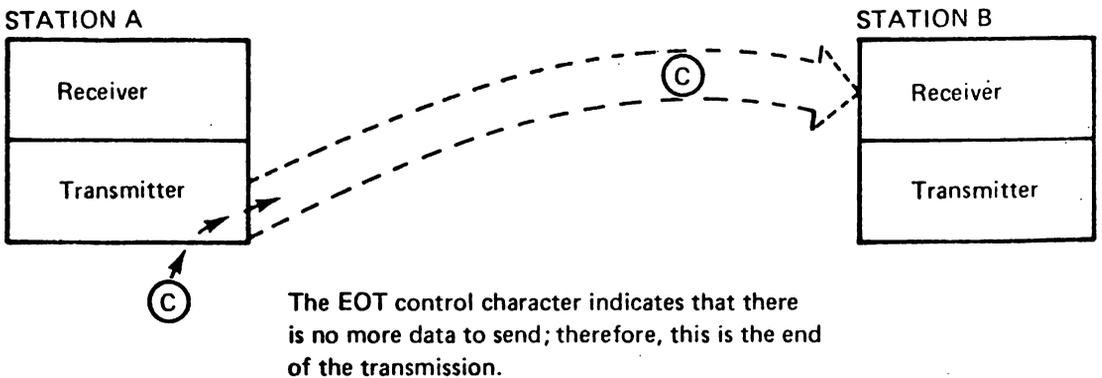
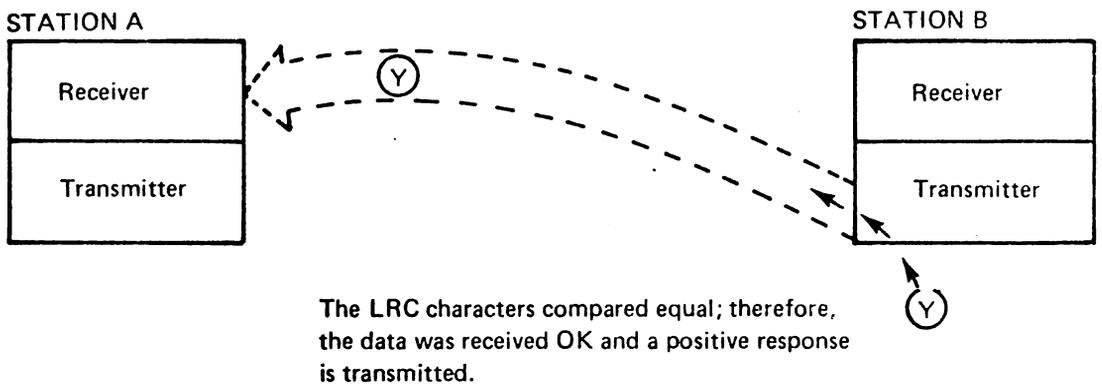
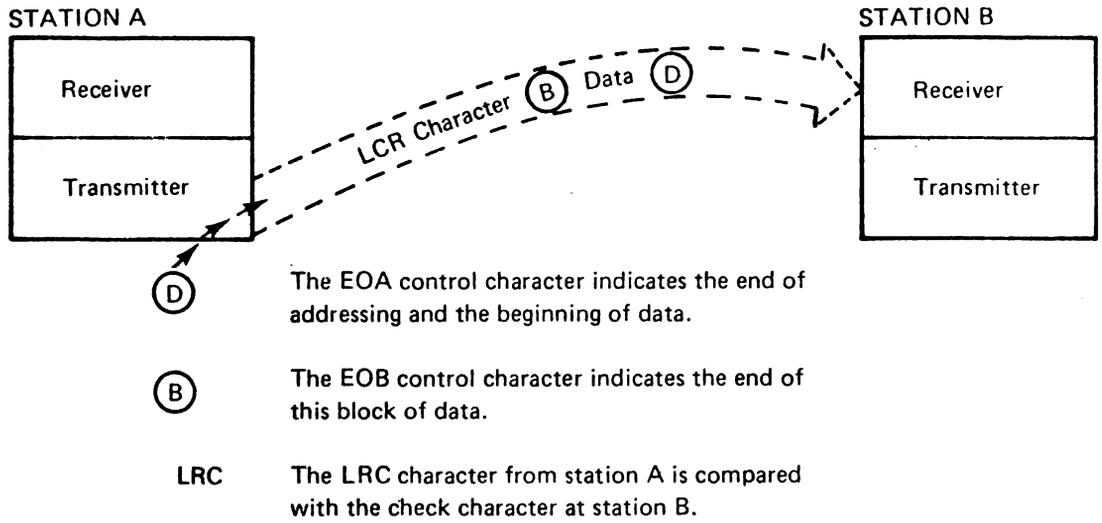
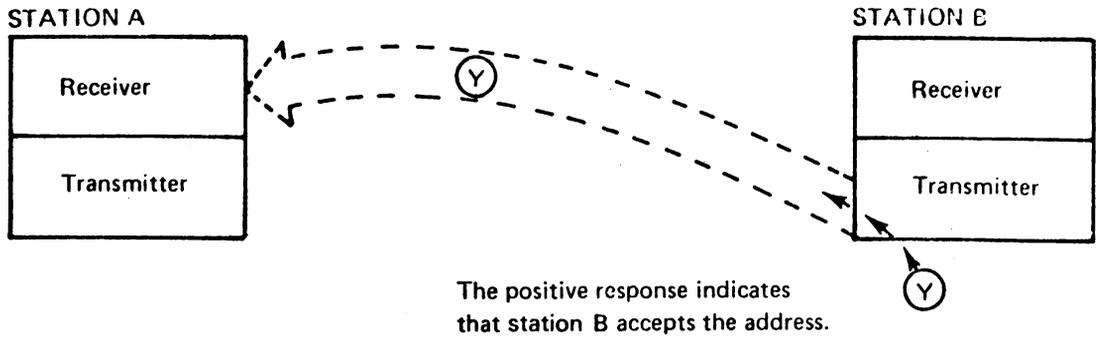
The most commonly used asynchronous transmission data link control characters and their functions are as follows:

Character	Alternate Designation	Function
ⓑ(circle B)	EOB (end of block)	Indicates the end of a block of data
ⓒ(circle C)	EOT (end of transmission)	Indicates the end of a message
ⓓ(circle D)	EOA (end of address)	Indicates the end of the terminal address or the beginning of data
Ⓝ(circle N)	Negative response	Indicates that data was not received correctly
Ⓢ(circle S)	SOA (start of address)	Indicates the beginning of a terminal address
Ⓨ(circle Y)	Positive response	Indicates that data was received correctly

The following example of control character sequence shows how a transmitting station might control the data link, using the data link control characters, to address and send data to another asynchronous station:

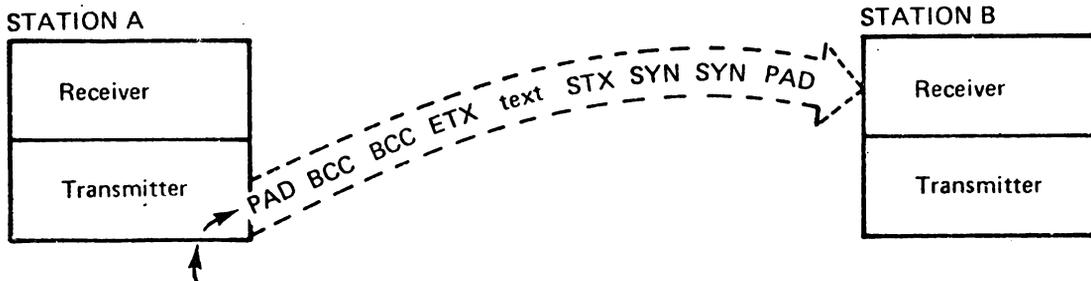


- ⓐ The EOT control characters reset all stations on the channel. (Only one ⓒ is necessary; however, two or three are sometimes sent to ensure that the terminals are reset.)
- Ⓢ The SOA control character tells all stations that an address follows.
- ⓑ The address (B) selects station B.



## BINARY SYNCHRONOUS

Binary synchronous communications (BSC) is synchronous transmission of binary coded data. In asynchronous transmission (start-stop), extra bits are needed with each character to obtain synchronization, and each data character is transmitted separately. In binary synchronous transmission, data, data link control, and other characters are transmitted together in a continuous series of bits as follows:



**PAD** **FIRST CHARACTER**—A **PAD** (padding character) to ensure that the modem transmits all bits of the first **SYN** character.

**SYN** At least two **SYN** (synchronization) characters to establish synchronization.

**STX** An **STX** (start of text) data link control character to indicate the beginning of data.

**text** The data.

**ETX** An **ETX** (end of text) data link control character to indicate the end of data.

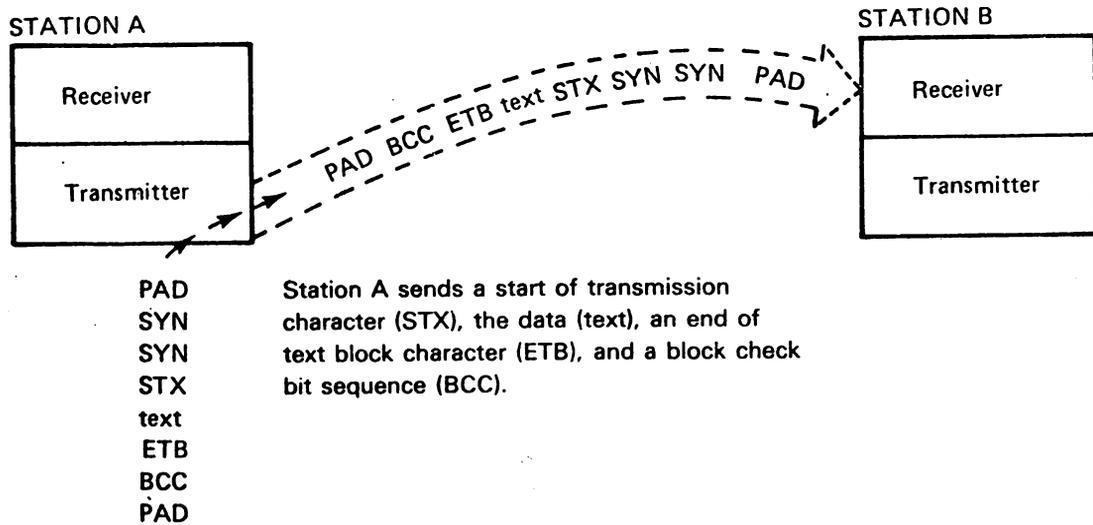
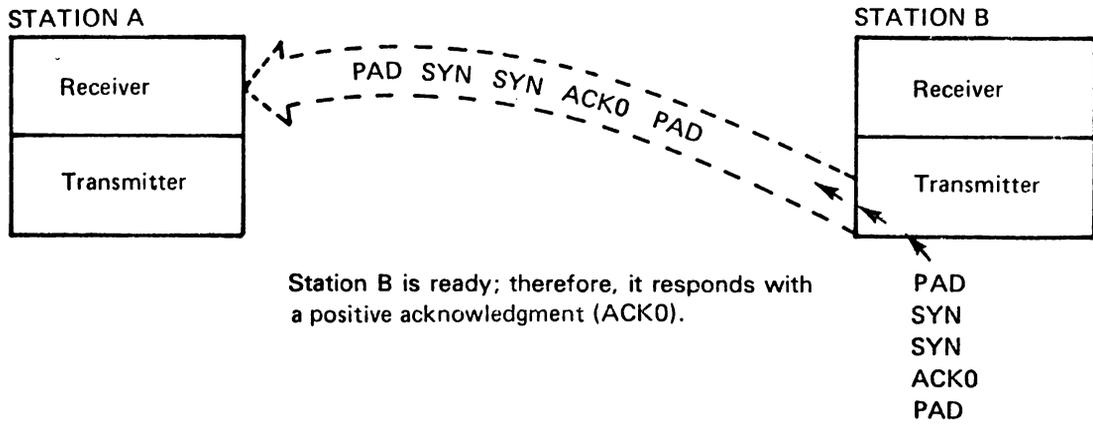
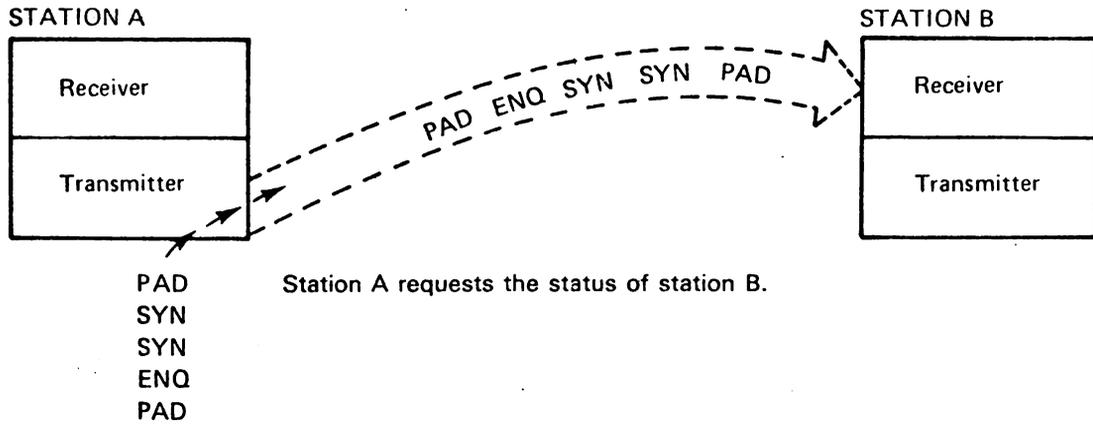
**BCC** The **BCCs** (block check characters) for error checking to ensure that all bits transmitted are also received.

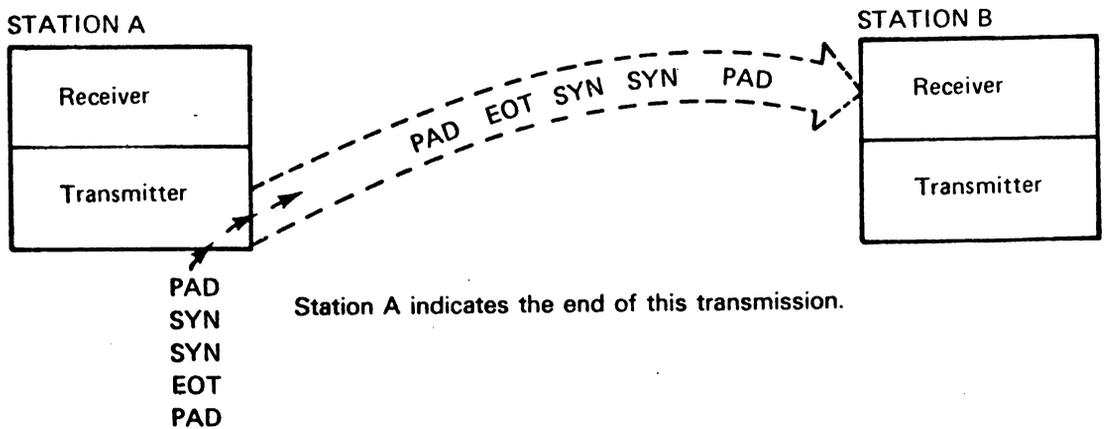
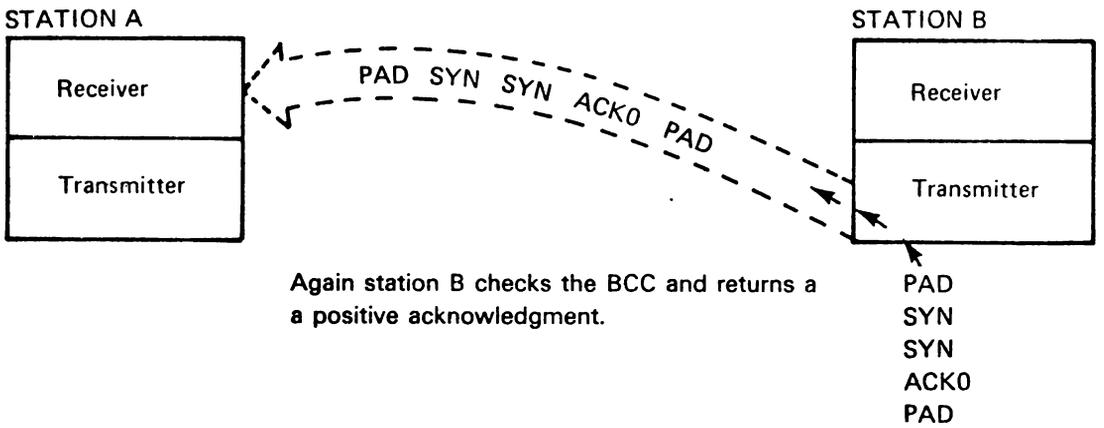
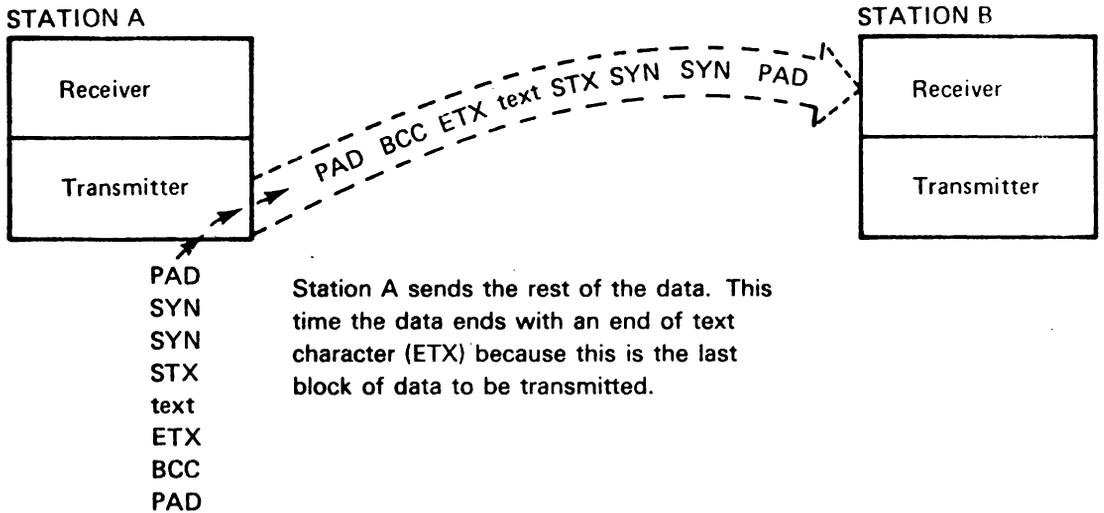
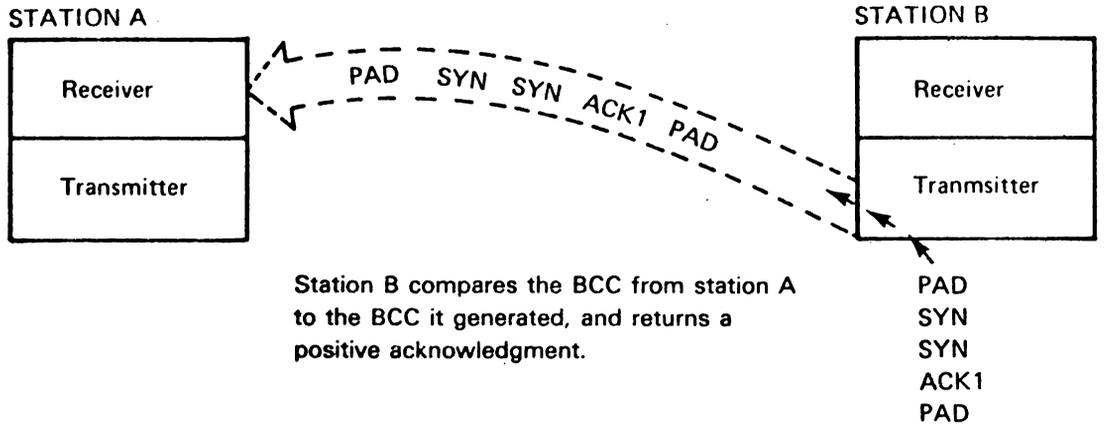
**PAD** A **PAD** character ensures that all bits of the last data link control or error checking character are transmitted.

The following is a list of the data link control characters used in binary synchronous communications and a brief description of their function:

<b>Character</b>	<b>Function</b>
SYN (sync)	Establishes and maintains synchronization
SOH (start of header)	Indicates the start of heading information
STX (start of text)	Indicates the start of text
IRS (interchange record separator)	Terminates an information block called a record
ITB (intermediate text block)	Divides a block of text into smaller groups of text (intermediate text blocks) for error checking
ETB (end of text block)	Indicates the end of a block of data but not the last block transmitted
ETX (end of text)	Indicates the end of a message and the last block of text
EOT (end of transmission)	Indicates the end of the transmission
ENQ (enquiry)	Has three functions: (1) initiates control of transmission on a point-to-point channel; (2) indicates the end of a polling or address sequence on a multipoint channel; and (3) indicates a request for a station to repeat its response
ACK0/ACK1 (alternating positive acknowledgments)	Indicates that text was received without errors
DLE (data link escape)	Allows transmission of all 256 characters of the EBCDIC code structure within text (called transparency)
RVI (reverse interrupt)	Transmitted by the receiving station instead of an ACK to stop the transmitting station from sending so that the receiving station can send data
TTD (temporary text delay)	Holds the communication link when not transmitting data
WACK (wait before transmitting)	Indicates to the transmitting station a positive acknowledgment and a temporary not ready condition
NAK (negative acknowledgment)	Indicates a not ready condition, that an error occurred, or is sent as a response to an ENQ
PAD (padding character)	Ensures that all bits of the first and last character of a message are transmitted.
BCC (block check sequence)	Used to check that all bits transmitted are also received.

The following example shows how some of these characters are used to control communications on a point-to-point channel:



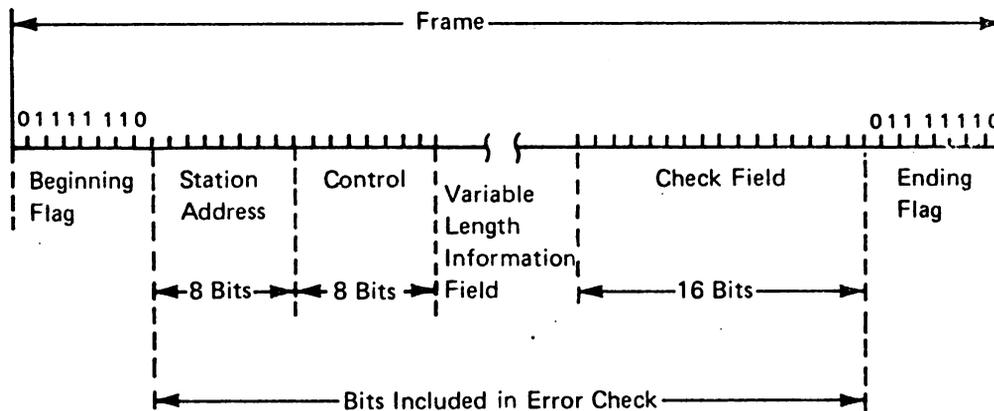


## SYNCHRONOUS DATA LINK CONTROL

Synchronous data link control (SDLC) uses synchronous transmission to transfer information over a data communications channel. Transmission exchanges may be duplex or half duplex. The channel may be point-to-point switched, point-to-point nonswitched, or multipoint. Synchronization is maintained by self-checking modems, or by the stations using internal machine clocking.

The primary station is the controlling station and the secondary station is the responding station. The primary station controls the communication link by sending commands to the secondary station, and the secondary station responds to the commands.

All information, including commands and responses, is transmitted between stations in groups of bits called frames as shown in the following example:



The beginning and end of each frame is indicated by a series of bits (01111110) called a flag.

An address field is used to identify the secondary station that is receiving or sending the frame.

The control field contains commands or responses to control the data link.

The information field contains the data that is transferred between stations. Any 8-bit code structure can be transmitted within this field, which allows all 256 character combinations to be transmitted. (This field may or may not be present depending on the content of the control field.)

The check field contains the CRC check sequence that is used to check data transmission validity.

## Control Field Format

The control field has three formats: the nonsequenced format, the supervisory format, and the information transfer format. The following example shows the three bit formats of the control field:

		Bits							
		0	1	2	3	4	5	6	7
Nonsequenced Format		**		P/F		**		1	1
Supervisory Format		Nr		P/F		*		0	1
Information Transfer Format		Nr		P/F		Ns			0


  
Poll/Final bit

\*Codes for supervisory commands or responses

\*\*Codes for nonsequenced commands or responses

The poll/final bit is used to control sending and receiving. A primary station sends the poll (p) bit to invite a secondary station to send data. In response to a frame with the poll bit on, a secondary station may send a single frame with the final bit on or multiple frames with the final bit on in the last frame to indicate the last frame transmitted.

The Nr and Ns counts are used in sequencing frames for more efficient use of the communication link. The transmitting station sequences each information frame it sends. This count is called the Ns count. A receiving station need not acknowledge each frame as it is received. The receiving station counts each error-free frame; the receive count is called the Nr count. The Nr count is advanced each time an error-free frame is received. If the Ns count in a received sequenced frame does not match the Nr count, the frame is out of sequence.

The transmitting station must retain all outstanding frames. The frames that were not received correctly, as indicated by the Nr count returned by the receiving station, must be sent again by the transmitting station. Up to seven frames can be transmitted before the receiving station acknowledges by sending the Nr count to the transmitting station.

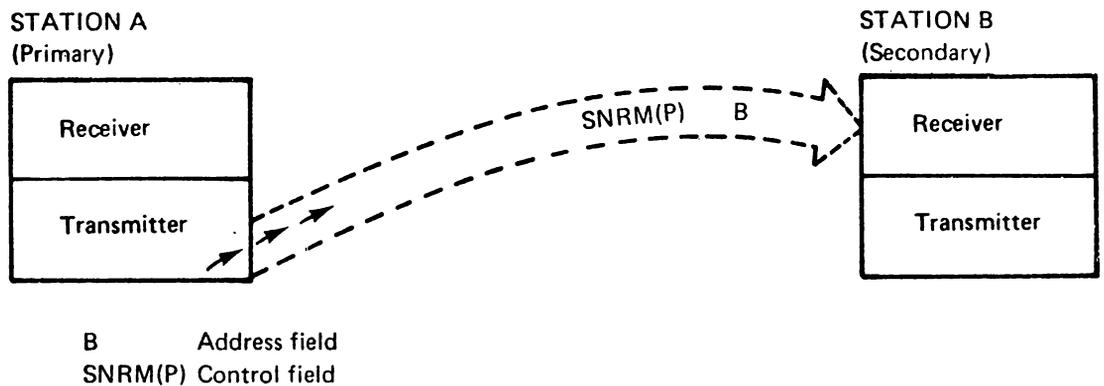
The commands and responses that are transmitted within the control field are described in the following chart:

Format	Binary Configuration	Acronym	Command	Response	I-Field Prohibited	Resets Ns and Nr	Confirms Frames Through Nr-1	Defining Characteristics
Nonsequenced	000 P/F 0011	NSI	X	X				Command or response that requires nonsequenced information
	000 F 0111	RQI		X	X			Initialization needed; expect SIM
	000 P 0111	SIM	X		X	X		Set initialization mode; the using system prescribes the procedures
	100 P 0011	SNRM	X		X	X		Set normal response mode; transmit on command
	000 F 1111	ROL		X	X			This station is offline
	010 P 0011	DISC	X		X			Do not transmit or receive information
	010 F 0011	RQD		X	X			Request disconnect
	011 F 0011	NSA		X	X			Acknowledge nonsequenced commands
	100 F 0111	CMDR		X				Non-valid command received; must receive SNRM, DISC, or SIM
	101 P/F 1111	XID	X	X				Exchange ID
	110 P/F 0111	CFGR	X	X				Configure
	111 P/F 0011	TEST	X	X				Test
	001 P/F 0011	NSP	X		X			Nonsequenced poll
	111 F 1111	BCN		X	X			Beacon
Supervisory	Nr P/F 0001	RR	X	X	X		X	Ready to receive
	Nr P/F 0101	RNR	X	X	X		X	Not ready to receive
	Nr P/F 1001	REJ	X	X	X		X	Transmit or retransmit starting with frame Nr
Information	Nr P/F Ns0	I	X	X			X	Sequenced I-Frame

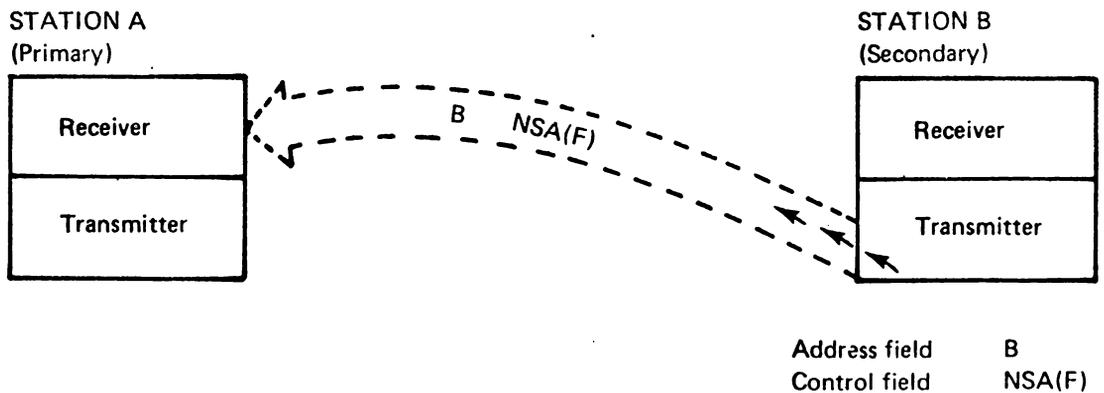
## Controlling the Communication Link

The following example shows the commands used and whether the poll or final bit is on during communications between a primary station and a secondary station. Assume that station B (the secondary station) is in normal disconnect mode. In this mode, station B cannot transmit until station A (the primary station) sets it in normal response mode. Station A does this with the SNRM (set normal response mode) command (the control field also contains the poll bit to allow station B to transmit):

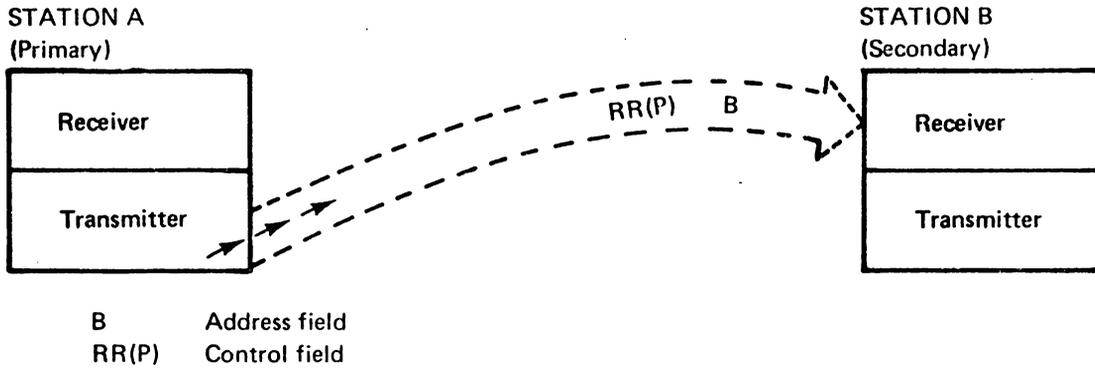
**Note:** The flags and check field are always transmitted with each frame, although they are not shown in the example. Also, the address field always contains the address of the secondary station.



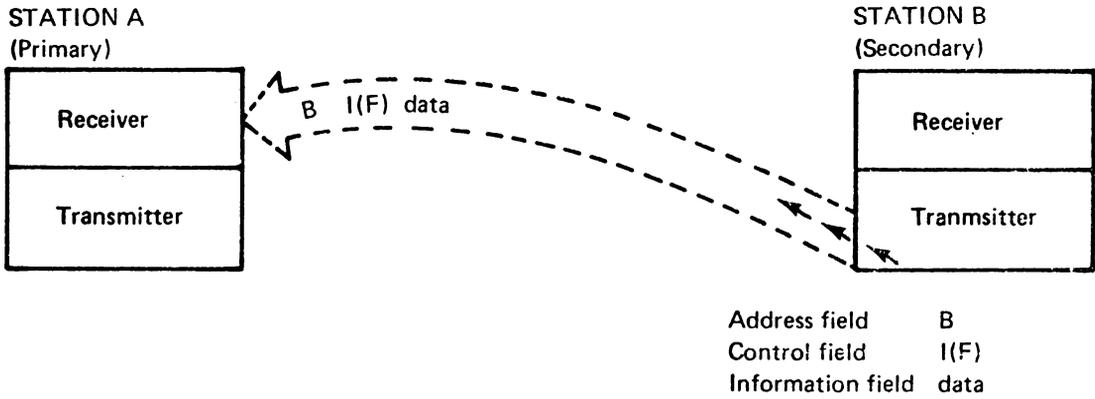
Station B acknowledges with an NSA (nonsequenced acknowledgment) response (the final bit is set on in response to station A):



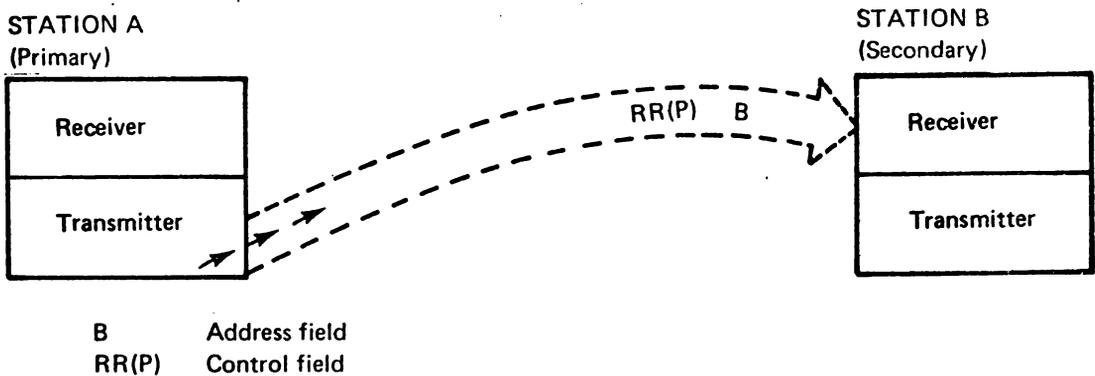
Station A invites station B to transmit with an RR (receive ready) command (the poll bit is set on to allow station B to transmit):



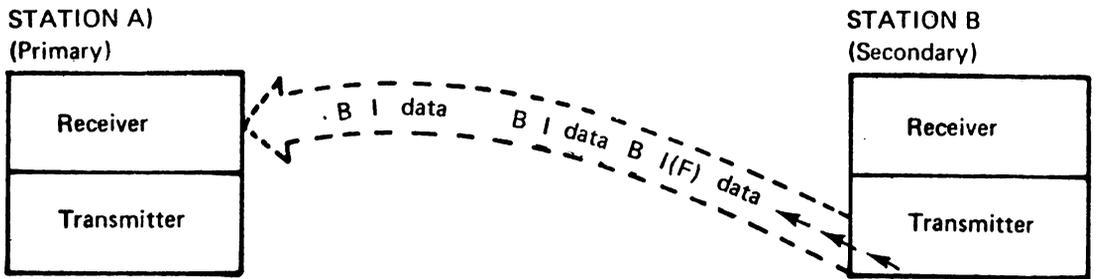
Station B sends an information frame (the final bit is on to indicate that this is the last frame):



Station A confirms receiving the information frame with an RR (receive ready) command (the poll bit is on to allow station B to send):

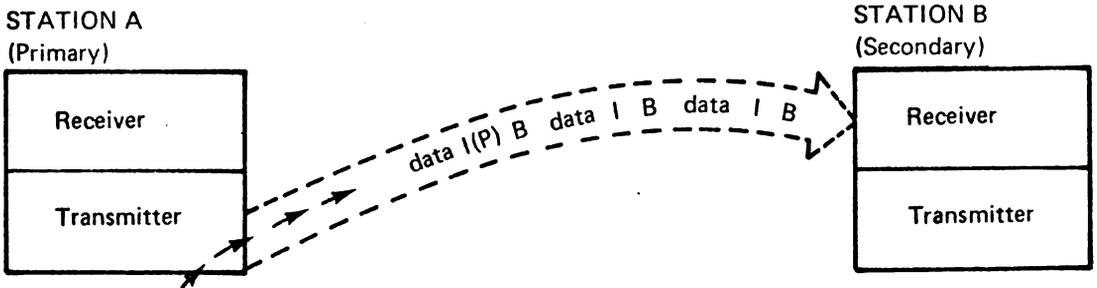


Station B responds by sending three sequenced information frames (the last frame has the final bit on to indicate that it is the last frame):



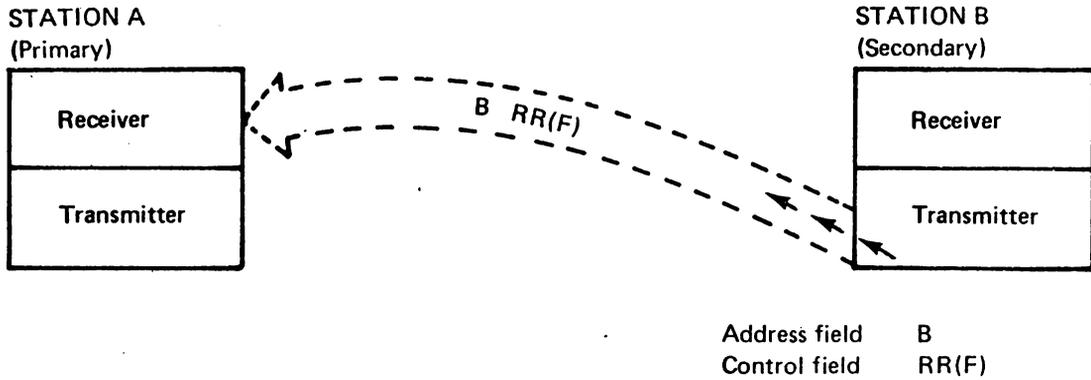
Address field	B
Control field	I
Information field	data
Address field	B
Control field	I
Information field	data
Address field	B
Control field	I(F)
Information field	data

Station A confirms the three information frames from station B by sending information frames (the poll bit is on in the last frame to indicate that it is the last frame and to allow station B to respond):

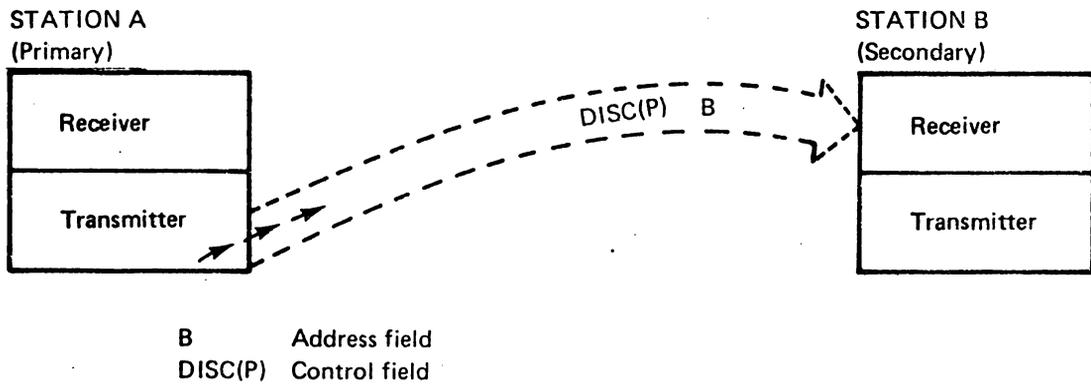


B	Address field
I	Control field
data	Information field
B	Address field
I	Control field
data	Information field
B	Address field
I(P)	Control field
data	Information field

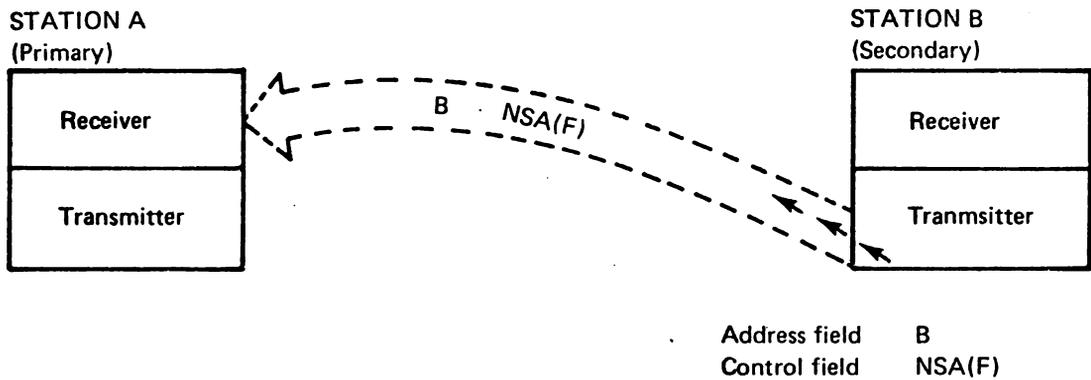
Station B confirms the three information frames from station A with an RR (request receive) command (the final bit is on in response to the poll bit from station A):



Station A sends a DISC (disconnect) command to set station B offline (the poll bit is on to allow station B to respond):



Station B acknowledges with an NSA (nonsequenced acknowledgment) response and assumes normal disconnect mode:



## **SYSTEMS NETWORK ARCHITECTURE**

Systems Network Architecture (SNA) relieves the communication system user of many network control and network resource management requirements, allowing him to concentrate on application functions. SNA formally defines the functional responsibilities of communication system components.

SNA communication products can perform functions that were formerly done by the main processor or host system. The functions distributed to these products may include the management of communication channels, device control, data formatting, and in some cases, execution of application programs.

The functions are distributed to three major functional elements, called layers, which are:

- The application layer, which performs the user's application processing
- The function management layer, which presents information from one application layer to another application layer
- The transmission subsystem layer, which routes data between origins and destinations

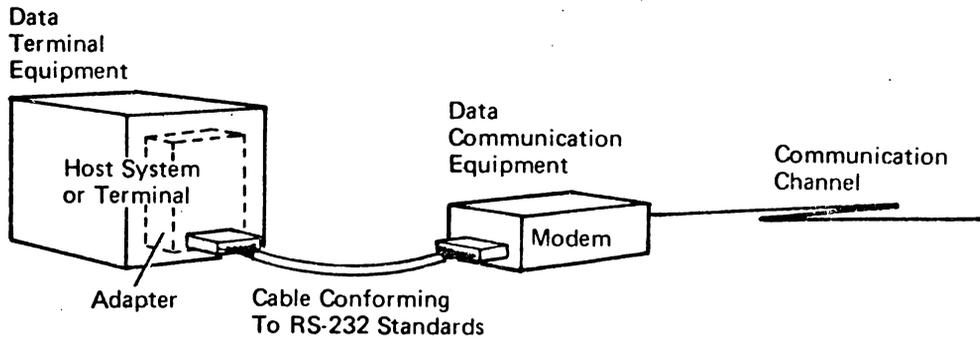
Distribution of function allows application programs and communication products to be added or changed without affecting other elements of the communication system.

## Chapter 5. Communication Adapters

For remote communications, the host or terminal must be connected to equipment that can transmit and receive data via a communication channel. Data processing equipment used for communications is called data terminal equipment (DTE) and equipment used to transmit data to and receive data from a communication channel is called data communications equipment (DCE).

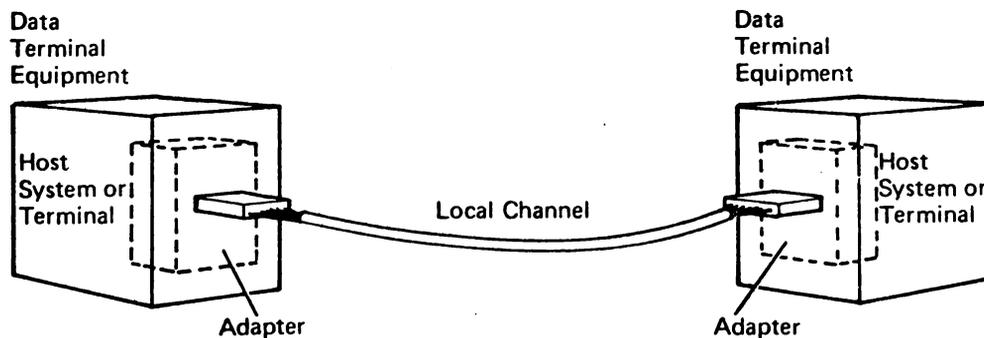
In GSD systems, an adapter (enclosed in the system) is used to connect data terminal equipment to data communications equipment or other data terminal equipment.

The connection (or interface) between DTE and DCE must be standardized or compatible. The most common interface between data terminal equipment and data communications equipment is the EIA (Electronics Industry Association) RS-232 standard interface as shown in the following illustration:



This interface defines the connector type, pin numbers, line names, and signal levels that are used to connect data terminal equipment to data communications equipment.

When a DTE is connected to another DTE by a local cable, the connections need not be standardized; however, adapters are still used as shown in the following example:



## **ADAPTER FUNCTIONS**

Some of the functions that communication adapters perform are:

- Receive and transmit data
- Add or remove control characters
- Convert bits into characters as they are received (assemble serial data into parallel data)
- Convert characters into bits as they are transmitted (convert the parallel data into serial data)
- Check data transmitted and received for accuracy
- Control timeouts
- Automatically call and/or answer calls on switched channels
- Automatically poll terminals on a multipoint channel

## **ADAPTERS FOR THE IBM SERIES/1**

The following adapters and controls are available for the IBM Series/1:

- Asynchronous communications single-line control
- Asynchronous communications 8-line control
- Asynchronous communications 4-line adapter
- Binary synchronous communications single-line control
- Binary synchronous communications single-line control high speed
- Binary synchronous communications 8-line control
- Binary synchronous communications 4-line adapter
- Synchronous data link (SDLC) single-line control

### **Asynchronous Communications Single-Line Control**

The asynchronous communications single-line control provides a half duplex cycle stealing attachment and control for a single asynchronous communication line. This control allows a Series/1 to function as a host system communicating with asynchronous (start/stop) devices, such as the IBM 2740 or IBM 2741 Communications Terminals or other asynchronous systems.

The number of asynchronous controls that can be installed on a Series/1 is determined by the number of available feature positions. (One feature position is required for each control.)

The asynchronous communications single-line control has the following features:

- It can communicate on a point-to-point switched channel, on a point-to-point nonswitched channel, or on a multipoint nonswitched channel.
- It allows data transmission speeds within two ranges, 37.5 to 1,200 bps or 300 to 9,600 bps.
- It allows external modems to be attached via an EIA RS-232C/CCITT V.24 interface.
- Under program control, it allows PTTC/EBCD, PTTC/Correspondence, or 8-bit data interchange operations.
- On switched lines, the link connection may be completed by manual call, manual answer, or automatic answer.

The asynchronous communications single-line control also has an optional local attachment feature that allows direct connection of a terminal to the control within a distance of 14.99 meters (50 feet).

#### **Asynchronous Communications Eight-Line Control**

The asynchronous communications eight-line control provides the control function for one or two asynchronous communications four-line adapters. Data transfer to and from main storage is via cycle stealing operation.

#### **Asynchronous Communications Four-Line Adapter**

The asynchronous communications four-line adapter provides for the attachment of up to four asynchronous (start/stop) communications lines. The four-line adapter requires as a prerequisite, and is controlled by the asynchronous communications eight-line control.

The features for this adapter are identical to those of the asynchronous communications single-line control except that the maximum data rate on the asynchronous communications four-line adapter is 2,400 bps per line.

The number of asynchronous features that can be installed on a Series/1 configuration is determined by the number of available feature positions. One feature position is required for each single-line control, and two or three feature positions are required for each eight-line control with four-line adapters. A maximum of 24 communication lines, of any adapter mixture, can terminate in any processor or I/O expansion unit.

## Binary Synchronous Communications Single-Line Control

The binary synchronous communications single-line control provides a half-duplex cycle stealing attachment and control for a single BSC line. This control allows the Series/1 to function as a processor terminal or to function as a host or subhost system with attached terminals.

The number of binary synchronous controls that can be installed on a Series/1 is determined by the number of available feature positions. (One feature position is required for each control.)

The binary synchronous communications single line control has the following features:

- Communication on a point-to-point switched channel, a point-to-point nonswitched channel, or a multipoint channel
- Attachment of external modems via an EIA RS-232C/CCITT V.24 interface
- Data transmission speeds up to 9,600 bps
- Internal clocking at 600 or 1,200 bps
- Either EBCDIC or ASCII codes
- Text Transparency (unrestricted binary data) when using EBCDIC
- Link connection on switched lines, completed by manual call, manual answer, or automatic answer
- Line error checking

**Note:** The type depends on the code selected—either EBCDIC-CRC (cyclic redundancy check) or ASCII LRC/VRC (longitudinal redundancy, and vertical redundancy checking).

- Intermediate block checking (ITB) provided on TRANSMIT/RECEIVE by the adapter
- The capability to receive an initial program load (IPL) from another system

## **Binary Synchronous Communications Single-Line Control/High Speed**

The binary synchronous communications single-line control/high speed provides a half duplex cycle stealing attachment and control for a single BSC line. This control allows the Series/1 to function as a processor terminal or a host or subhost system with attached terminals.

The number of binary synchronous controls/high speed that can be installed on a Series/1 is determined by the number of available feature positions. (One feature position is required for each control.)

The binary synchronous communications single-line control/high speed has the following features:

- Communication on a point-to-point nonswitched channel or on a multipoint channel
- Attachment via a Western Electric 303 data set (or equivalent) or with CCITT V.35 compatible data sets
- Data transmission speeds up to 56K bytes per second
- Either EBCDIC or ASCII codes
- Text transparency (unrestricted binary data) when using EBCDIC
- Line error checking

*Note:* The type depends on the code selected, EBCDIC-CRC (cyclic redundancy check) or ASCII-LRC/VRC (longitudinal redundancy, and vertical redundancy checking).

- Intermediate block checking provided by a block check character (BCC)
- The capability to receive an IPL (initial program load) from another system

## **Binary Synchronous Communications Eight-Line Control**

The binary synchronous communications eight-line control provides the control function for one or two binary synchronous communications four-line adapters. Data transfer to and from main storage is via a cycle-stealing operation.

## **Binary Synchronous Communication Four-Line Adapter**

The binary synchronous communications four-line adapter provides for the attachment of up to four half-duplex BSC lines. The BSC four-line adapter is controlled by a binary synchronous communications eight-line control feature.

The features for this adapter are identical to those of the binary synchronous communications single-line control except that the IPL feature is not supported on the four-line adapter.

The number of binary synchronous communications features that can be installed on a Series/1 configuration is determined by the number of available feature positions. One feature position is required for one single-line or single-line/high speed control. Two or three feature positions are required for each eight-line control with four-line adapters. A maximum of 24 communication lines of any adapter mixture can terminate in any processor or I/O expansion unit.

## **Synchronous Data Link Control (Single-Line)**

The Synchronous Data Link Control (SDLC) provides a half-duplex cycle stealing attachment for a single SDLC communications line.

The SDLC has the following features:

- Communication on a point-to-point switched channel, a point-to-point nonswitched channel, or a multipoint channel
- Data transmission speeds up to 9,600 bps
- Attachment of external modems via an EIA RS-232C/CCITT V.24 interface
- Internal clocking at 600 or 1,200 bps
- Either EBCDIC or ASCII codes as well as transparent operation
- Link connection on switched lines completed by manual call, manual answer, or automatic answer
- Frame CRC checking/generation checking provided by the adapter via the FCS (frame check sequence) field
- Automatic zero insertion and deletion provided by the adapter to allow transparent text operation
- Two programmable timers

## Communications Indicator Panel

The communications indicator panel is available as an option to any of the Series/1 communications features. This panel provides a means of displaying various states, conditions, and lines. It also provides a means of manually resetting the 'data terminal ready' line to the modem. The indicator panel may be used with any of the communications features, one line at a time.

## IBM Series/1 4987 Programmable Communications Subsystem

The IBM Series/1 4987 Programmable Communications Subsystem allows the usage of Series/1 in a wide range of applications. It is a cycle-stealing device that allows communications functions to be done outside the IBM Series/1 processor.

### Highlights

The 4987 provides line attachment via external modems, direct connection, current interface, integrated modems, and Data-Phone<sup>1</sup> digital service. It can accommodate asynchronous or synchronous disciplines at speeds up to 9,600 bps on either switched or non-switched facilities. It also provides auto-calling and auto-answering capabilities.

Features that are program selectable on a per line basis are:

- Synchronous/asynchronous line operation
- Switched/nonswitched facility
- 5, 6, 7, and 8 bits per character
- 1, 1.5, and 2 stop bits per character
- Internal or external clocking
- Speeds of 45.5 to 9,600 bps
- Least/most significant bit character orientation
- Parity (VRC) checking of odd, even, or none
- Scanning priority sequence of each line
- LRC generation/checking (longitudinal redundancy check)
- CRC generation/checking (cyclic redundancy check) for standard (BSC) or user-specified polynomials

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<sup>1</sup> Trademark of the American Telephone & Telegraph Co.

In addition to the features that are program selectable, the user has programmable storage in the 4987 for communications protocol handling programs. A special communications oriented instruction set is provided for this purpose. This allows the following communications functions to be done outside the Series/1 processor:

- Protocol handling
- Control character generation and recognition
- Chaining of I/O operations
- Timer functions
- Auto-polling of multipoint lines
- Error retry functions
- Break signal processing
- Uppercase/lowercase character recognition and generation
- Auto-calling

The 4987 has program initiated capability for internal diagnostics, tracing data or tracing operations of the 4987, and dumping the contents of the 4987 to the Series/1 for program debug or problem determination.

#### **IBM Series/1 4990 Model 1 Communications Console for the 4987**

The 4990 Communications Console for the 4987 is an optional hand-held console. The console provides the capability for program debug and problem determination external to the Series/1 processor.

#### **IBM Series/1 Auto-Call Originate Attachment Card (RPQ)**

This RPQ provides an EIA RS366 (comparable to Series 200 leads as defined in CCITT V.24 with electrical characteristics as defined in CCITT V.28) interface suitable to control auto-call modems via Series/1.

Highlights of this support:

- This card provides 12 input lines and 12 output lines for controlling up to two auto-call modems under direct program control.
- This card also provides 16 DI/PI nonisolated points and 16 DO (digital output) nonisolated points under direct program control.
- The card may be used in any I/O slot of processor rack modules 4953 or 4955 or I/O expansion enclosure 4959.

## **ADAPTERS FOR THE IBM SYSTEM/3**

The following adapters are available for the IBM System/3:

- Binary synchronous communications adapter (BSCA) for Models 4, 6, 8, 10, 12, and 15
- Binary synchronous communications controller (BSCC) for Model 15D
- Multiple line terminal adapter RPQ (MLTA) for Models 10, 12, and 15
- Integrated communications adapter (ICA) for Models 8 and 12
- Local communications adapter (LCA) for Models 6, 10, and 15
- Local display adapter (local DA) for Models 8, and 12
- Display adapter (DA) for Model 15
- Integrated display adapter for Model 4

The following is a brief description of each adapter.

### **Binary Synchronous Communications Adapter**

The binary synchronous communications adapter (BSCA) allows a System/3 Model 4, 8, 10, 12, or 15 to function as a processor terminal, or to function as a host or subhost system with attached terminals. The BSCA allows a System/3 Model 6 to function as a processor terminal.

One or two BSCAs can be installed on a System/3 Model 8, 10, 12, or 15 and one BSCA on the Model 4 or 6.

The binary synchronous communications adapter has the following features:

- A BSCA display panel for each adapter
- An automatic answering feature that automatically answers incoming calls on a switched channel
- A choice of either the EBCDIC or the ASCII code structure
- A selection of data transmission speeds of 600 to 9,600 bps or high speed (wide band) rates up to 50,000 bps

In addition to the preceding features, the following optional features are available for the BSCA:

- An automatic calling feature that automatically dials (under program control) stations on a switched channel. (The stations must be able to automatically answer the calls.)
- A text transparency feature that allows the System/3 to transmit or receive all 256 EBCDIC characters as data. The text transparency feature is needed to transmit or receive machine language programs or packed data.
- A self-clocking feature for modems that do not provide clocking signals.
- A station selection feature that allows the system to function as a terminal (tributary station) on a multipoint channel.
- An EIA local attachment feature that permits direct communications (without modems) within short distances to other devices that use the EIA interface.
- An EIA interface feature that permits remote communications by allowing the attachment of a modem that uses the EIA RS-232C interface.

The BSCA can be used with nonswitched point-to-point channels, multipoint channels (Model 6 as a multipoint tributary station only), and switched channels.

The BSCA uses cyclic redundancy checking (CRC) to check data transmission validity when using the EBCDIC code structure, and longitudinal redundancy checking (LRC) with vertical redundancy checking (VRC) when using the ASCII transmission code.

## **BINARY SYNCHRONOUS COMMUNICATIONS CONTROLLER**

The binary synchronous communications controller (BSCC) allows a System/3 Model 15D to function as a host system with attached terminals.

One or two BSCCs can be installed on a Model 15D.

The binary synchronous communications controller has the following features:

- A BSCC display panel for each adapter.
- A choice of either the EBCDIC or the ASCII code structures.
- A selection of data transmission speeds of 600 to 9,600 bps.
- A text transparency feature that allows the System/3 Model 15D to transmit or receive all 256 EBCDIC characters as data. (The text transparency feature is needed to transmit or receive machine language programs or packed data.)
- A terminal polling function, which is independent of the CPU thus reducing CPU loading.

The binary synchronous communications controller (BSCC) is mutually exclusive with the multiple line terminal adapter (MLTA).

## **Multiple Line Terminal Adapter**

The multiple line terminal adapter RPQ allows a System/3 Model 10, 12, or 15 to function as a host system communicating with asynchronous (start-stop) devices, such as the 2740 or 2741 Communication Terminal or other asynchronous systems.

One multiple line terminal adapter can be installed on the System/3.

The multiple line terminal adapter has the following features:

- It can communicate on a point-to-point switched channel, on a point-to-point nonswitched channel, or as a control station on a multipoint nonswitched channel.
- It allows data transmission speeds of 134.5 to 1,200 bps.
- It allows external modems to be attached via an EIA RS-232B or RS-232C interface, or the attachment of IBM limited distance type II line adapters.
- It allows up to eight channels to be attached. A different type modem, IBM line adapter, and/or terminal can be attached to each channel. For example, one or more 1050 Data Communication Systems may be connected to one channel while one or more 2740 Communication Terminals are connected to another channel.

The MLTA has the following optional features:

- A two speed feature that allows the MLTA to communicate with both 134.5 and 600 bps transmission speeds simultaneously, however, not on the same channel
- An automatic polling feature that allows the MLTA, rather than a program, to poll terminals on a multipoint nonswitched channel to save System/3 processing time

## **Integrated Communications Adapter**

The integrated communications adapter (ICA) allows a System/3 Model 8 or 12 to communicate via binary synchronous communications with terminals or other binary synchronous devices on both local or remote channels. Up to three channels (two local and one remote) may be attached; however, only one channel may be active at one time. An operator can select the active channel with a switch on the operator panel.

The ICA can:

- Communicate on a point-to-point switched channel, on a point-to-point nonswitched channel, or on a multipoint nonswitched channel
- Communicate at speeds up to 8,000 bps directly (without modems) with a 3271 Control Unit or a 3275 Display Station
- Communicate directly (without modems) with a binary synchronous terminal, such as the IBM 3741 Model 2 or 4, at speeds up to 2,400 bps
- Communicate with remote binary synchronous devices, via modems, at 4,800 bps maximum on switched channels, and 7,200 bps maximum on nonswitched channels

The integrated communications adapter has the following features:

- An operator control panel. If the BSCA is installed, a switch on the panel allows either the BSCA or the ICA operational indicators to be selected.
- A choice of either the EBCDIC or ASCII code structure.
- An optional text transparency feature for the EBCDIC transmission code to transmit and receive all 256 EBCDIC characters as data.

#### **Local Communications Adapter**

The local communications adapter (LCA) allows the System/3 Model 6, 10, and 15 to communicate with one 3741 Model 2 or 4, one 3275 Display Station, or one 3271 Control Unit directly to the System/3 without modems. The adapter uses the EBCDIC transmission code and transmits and receives data at 2,400 bps. Communication is binary synchronous using the EBCDIC transmission code structure.

#### **Local Display Adapter**

The local display adapter allows the System/3 Model 8 or 12 to communicate directly (without modems or a 3271 Control Unit) with 3270 devices.

Up to 12 terminals can be attached to the local display adapter via a single coaxial cable per terminal with a maximum cable length of 2,000 feet per cable.

A terminal polling function that is independent of the CPU thus reducing CPU loading is available.

## **Display Adapter**

The display adapter allows the System/3 Model 15 to communicate directly (without modems or a 3271 Control Unit) with 3270 devices.

Up to 30 terminals can be attached to the display adapter via a single coaxial cable per terminal, with a maximum cable length of 2,000 feet per cable.

A terminal polling function that is independent of the CPU thus reducing CPU loading is available.

## **Integrated Display Adapter**

The integrated display adapter allows the System/3 Model 4 to communicate directly (without modems or a 3271 Control Unit) with 3270 devices.

Up to six terminals can be attached to the Model 4 via a single coaxial cable per device with a maximum cable length of 2,000 feet per cable.

A terminal polling function that is independent of the CPU thus reducing CPU loading is available.

## **ADAPTERS FOR THE SYSTEM/7**

The following adapters are available for the System/7:

- Asynchronous Communications Control Attachment (ACCA) Feature
- Asynchronous Communications Control Adapter 50KB (RPQ D08000)
- Asynchronous Communications Control Adapter 1200 (RPQ D08001)
- Asynchronous Communications Control Master (RPQ S65005)
- Binary Synchronous Communications Adapter (BSCA)
- 5098-N03 Binary Synchronous Communications Module (RPQ D08080)
- Binary Synchronous Communications Adapter-9600 bps (RPQ S65035)
- Teleprocessing Multiplexer Feature (RPQ D08010)
- 5098-N01 Teleprocessing Multiplexer Module (RPQ D08011)

## **Asynchronous Communications Control Attachment (ACCA)**

The ACCA (asynchronous communications control attachment) is an optional feature that resides in the IBM 5010 Processor Module Models A and E. It controls the transfer of data to and from a host processor at a remote location via data set and a communications line facility. The ACCA can be used for connecting a System/7 to telecommunication equipment or other processors having compatible adapters. The ACCA allows the System/7 to function as a processor terminal to a System/3, a System/360 (Model 25 and larger), a System/370, or an 1800 Data Acquisition and Control System.

One ACCA can be installed on the System/7. The asynchronous communications control attachment has the following features:

- Data transmission is serial-by-bit using the start/stop method of character and bit synchronization at speeds up to 2,400 bits per second.
- The code structure used is the IBM PTTC/EBCD (Paper Tape Transmission Code/Extended Binary Coded Decimal).
- The ACCA operates in half-duplex mode; that is, the System/7 or host processor can either transmit or receive data. However, ACCA cannot transmit *and* receive data simultaneously.
- The ACCA can communicate with a host processor over private lines, leased common-carrier facilities, or switched voice grade common-carrier lines.
- The ACCA can be used with point-to-point channels or multipoint channels.

## **Asynchronous Communications Control Adapter 50KB (RPQ D08000)**

The asynchronous communications 50KB adapter RPQ modifies the ACCA to provide high speed in-house (private line) data transmission (speeds up to 50,000 bps with an IBM 1800 or System/360 and System/370 that have compatible ACCA features installed). Data transmission is serial-by-bit with the use of the start/stop method of character and bit synchronization. The same System/7 I/O commands and data formats are used with the standard ACCA feature.

Only one ACCA 50KB adapter can be installed on a System/7.

## **Asynchronous Communications Control Adapter 1200 (RPQ D08001)**

The asynchronous communications 1200 adapter RPQ modifies the ACCA to allow data transmission at 1,200 bits per second in half-duplex mode.

Only one ACCA 1200 can be installed on a System/7.

### **Asynchronous Communications Control Master (RPQ S65005)**

The asynchronous communications control master RPQ allows the System/7 to function as a master station (host) and provides an attachment for IBM 2740 Models 1 and 2, 1050, 3767 (with RPQ MG1587) or other System/7s as terminals on the ACCA.

One asynchronous communications control master RPQ can be installed on a System/7.

### **Binary Synchronous Communications Adapter (BSCA)**

The BSCA (binary synchronous communications adapter) is an optional feature that may reside in the 5010 Processor Module Models A or E. The adapter controls the transfer of serial data to and from another system at a remote location via a data set and communications line facility.

The BSCA allows the System/7 to function as a satellite processor with various processors having their own binary synchronous facility, such as, System/3, System/370, (Model 115 or larger), or another System/7.

One BSCA can be installed on a System/7.

The System/7 operates as a processor terminal on point-to-point networks and as a tributary station on multipoint networks. The System/7 communicates with the System/32 on point-to-point networks only.

The BSCA has the following features:

- It can provide IPL functions from the host processor with which it is communicating.
- The BSCA operates in half-duplex mode, switched, nonswitched or multi-point lines, and in a point-to-point network.
- Data to be transmitted or received by the System/7 is presented to the BSCA in EBCDIC or ASCII code structure.
- The BSCA can communicate with another system over private lines, leased common-carrier facilities, or switched voice-grade common-carrier lines.
- Integrated adapters or modem attachments are available.
- Data rates are from 600 to 50,000 bps (bits per second) depending on the modem selected.
- An automatic answering feature is available.

### **5098-N03 Binary Synchronous Communications Module (RPQ D08080)**

The binary synchronous communications module allows the System/7 to communicate with other BSC devices at speeds up to 50,000 bits per second. The module can house up to four binary synchronous adapters on a System/7. Data transfers between the System/7 processor and this BSC module are on an interrupt-per-character basis. Support is provided for point-to-point (switched or leased lines) or multipoint (tributary only) data links.

One BSC module may be installed on a System/7.

### **Binary Synchronous Communications Adapter-9600 BPS (RPQ S65035)**

The binary synchronous communications adapter (9600 bps) allows the System/7 to communicate with other BSC devices capable of operating at 9600 bps.

One BSC (9600) may be installed on a System/7.

### **Teleprocessing Multiplexer Feature (RPQ D08010)**

The teleprocessing multiplexer feature RPQ allows synchronous or asynchronous communication between System/7 and other terminals and systems. This feature is housed in a 5013 Digital Input/Output Module. A single feature can have up to eight half-duplex or four full-duplex communication line adapters; each System/7 can have up to eleven 5013 Modules, for a total of 88 communication lines. This teleprocessing multiplexer can operate at speeds from 75 to 1,200 bps with internal clocking or at speeds up to 9,600 bps with data set clocking.

The programming support is consistent with MSP/7 (Modular System Program/7) and can be extended to include selected BSC terminals or computers such as the IBM 3271 and 1130 with speeds up to 9,600 bps.

### **5098-N01 Teleprocessing Multiplexer Module (RPQ D08011)**

The TPMM (teleprocessing multiplexer module) RPQ allows synchronous or asynchronous communication between System/7 and other terminals and systems. The teleprocessing multiplexer basic interface is installed at an I/O module location within a 5026 enclosure. A single module can have up to 16 half-duplex or eight full-duplex communication line adapters; each System/7 can have up to 11 modules, for a total of 176 communication lines.

IBM programming support supplies macros consistent with MSP/7 so that you can attach, through this module, the IBM 2740 Model 1, 2741, 1030, 1050, or another System/7 as a data communications terminal. This teleprocessing multiplexer feature can be extended to include selected BSC terminals or computers such as the IBM 3271 and 1130 with speeds up to 9,600 bps.

A System/7 with a single TPMM (teleprocessing multiplexer module) can control up to sixteen 3707s on a point-to-point basis and up to 255 3707s using the multidrop method. Additional 3707s can be controlled by adding TPMMs and the maximum number varies from one application to another.

## **ADAPTERS FOR THE IBM SYSTEM/32**

The following adapters are available for the System/32:

- The binary synchronous communications adapter (BSCA)
- The synchronous data link control (SDLC) adapter

### **Binary Synchronous Communications Adapter**

The binary synchronous communications adapter (BSCA) allows the System/32 to function as a host, a processor terminal, or an RJE or MRJE work station. One BSCA can be installed on a System/32, and it can communicate on a switched point-to-point channel, a nonswitched point-to-point channel, or as a tributary station on a multipoint channel.

The BSCA uses cyclic redundancy checking (CRC) to check data validity when using the EBCDIC code structure, and longitudinal redundancy checking (LRC) with vertical redundancy checking (VRC) when using the ASCII code structure.

The binary synchronous communications adapter has the following features:

- A BSCA display panel.
- An automatic answering feature that automatically answers incoming calls on a switched channel.
- A choice of either the EBCDIC or the ASCII code structure (selected by a user program).
- A selection of data transmission speeds of 600 to 9,600 bps.
- A text transparency feature (selected by a user program) that allows the system to transmit or receive all 256 EBCDIC characters as data. The text transparency feature is needed to transmit or receive machine language programs or packed data.
- A station selection feature (selected by a user program) that allows the System/32 to function as a terminal on a multipoint channel.

In addition to the preceding features, the following optional features are available for the BSCA:

- A self-clocking feature for modems that do not provide clocking signals
- An EIA interface feature that permits remote communications by allowing attachment of a modem that uses the EIA RS-232C interface
- An integrated modem for 1,200 bps and an integrated modem for 2,400 bps that includes a feature for switched network backup

## **Synchronous Data Link Control Adapter**

The synchronous data link control (SDLC) adapter allows the System/32 to function as a processor terminal (under stored program control) when connected to a System/370.

One SDLC adapter can be installed on the System/32 to allow communications on nonswitched point-to-point channels, switched point-to-point channels, or as an SDLC secondary station on a multipoint channel. The adapter uses cyclic redundancy checking (CRC) to check data validity.

The synchronous data link control adapter has the following features:

- An SDLC display panel
- An automatic answering feature that automatically answers calls on a switched channel
- A choice of transmission speeds of 600 to 7,200 bps
- A station selection feature that allows the System/32 to function as a terminal on a multipoint channel

In addition to the preceding features, the following optional features are available for the SDLC adapter:

- A self-clocking feature for modems that do not provide clocking signals
- An EIA interface feature that allows the attachment of a modem (for remote communications) that uses the RS-232C interface
- An integrated modem for 1,200 bps and 2,400 bps, and an integrated modem for 2,400 bps only that also includes a feature for switched network backup

## **ADAPTER FOR THE IBM SYSTEM/34**

The System/34 communications adapter feature allows System/34 to communicate using binary synchronous communications or synchronous data link control. The System/34 can have one or two of these adapters operating in any combination of binary synchronous communications and synchronous data link control, as selected by the programs.

The communications adapter feature allows a maximum transmission rate of 9,600 bps. The communications adapter operates in half-duplex over point-to-point and multipoint networks (only as a tributary station with BSC), including four-wire communications lines. A System/34 on a switched network supports manual dialing and manual answering. System/34 supports automatic answering only when the attached modem (external or integrated) also supports it. The adapter uses cyclic redundancy checking for EBCDIC data and longitudinal redundancy checking with vertical redundancy checking for ASCII data.

Other features of the communications adapter include:

- Program selection of either BSC or SDLC
- Program selection of ASCII, EBCDIC, or EBCDIC transparency (BSC only)
- Full rate or half rate selection by a utility prior to execution of a program
- An EIA/CCITT interface feature that permits attachment of a modem that uses the EIA RS-232C interface
- An internal clocking feature for transmission rates of either 600 bps or 1,200 bps
- Attachment of a Data-Phone<sup>1</sup> digital service adapter for communicating on AT&T's digital data network
- An integrated modem for 1,200 bps transmission
- A 2,400 bps integrated modem that includes switched network backup
- A communications display panel

The adapter allows the System/34 to:

Function as a host, a processor terminal, or as a MRJE work station with the BSC feature

Function as a host to remote 5250 display stations, a subhost, a processor terminal or as an RJE work station using SDLC

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<sup>1</sup>Trademark of the American Telephone & Telegraph Co.

## **ADAPTER FOR THE IBM 5230 DATA COLLECTION SYSTEM**

The adapter available for the 5230 system is BSCA (binary synchronous communications adapter).

The BSCA permits the 5231 Model 2 Controller to function as a terminal communicating in binary synchronous mode.

BSCA has the following features:

- A selection of switched or nonswitched point-to-point or multipoint nonswitched lines

Switched network versions that support manual dial and manual or autoanswer operations

- An EBCDIC transmission code in a nontransparent mode
- A selection of data transmission speeds (600 to 4,800 bps)

In addition to the preceding features, the following optional features are available for the BSCA:

- A self-clocking feature for modems that do not provide clocking signals
- An EIA interface feature that permits remote communications by allowing attachment of a modem that uses the EIA RS-232C interface
- An integrated modem for 1,200 bps transmissions over nonswitched or switched facilities (with autoanswer)

The terminal is the input and/or output station of the data communications system. Some terminals include a combination of devices to perform a variety of functions.

Terminals can be used to:

- Enter data from a keyboard
- Read cards
- Read magnetic disks and diskettes
- Read paper tape
- Read encoded badges
- Punch cards
- Write magnetic disks and diskettes
- Punch paper tape
- Print reports
- Display data on display screens

Some terminals transmit data directly to a host or other terminals as it is entered. Other terminals store the data for later transmission.

Some terminals can be programmed, allowing control of some functions at the terminal to relieve the host of these functions.

In some configurations, a system may be a terminal. For example, the System/3 can be a processor terminal. As a processor terminal, the System/3 sends information to and receives information from a larger computer, such as an IBM System/370, which is referred to as the central system, central computer, or host system.

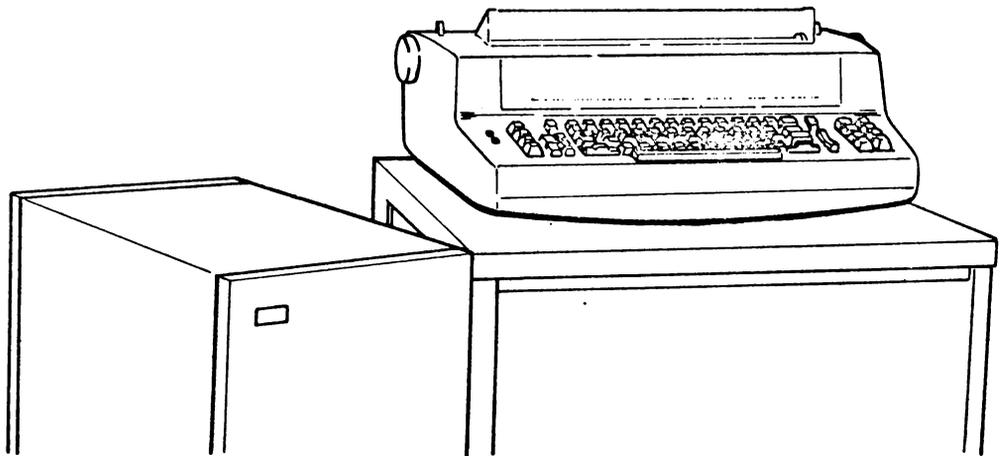
Certain items about the terminal and host system should be considered before selecting a terminal; such items as:

- The synchronization
- The transmission speed
- The volume of data being handled
- The type of channel
- The use of programmable terminals
- The use of mass storage at the terminal for remote batch entry

Your IBM marketing representative can assist you in selecting the proper terminal.

The following is a brief description of the terminals that can be used with IBM GSD products. For more information about a terminal, see the appropriate publication referenced under *Terminals* in Appendix B, *Bibliography*.

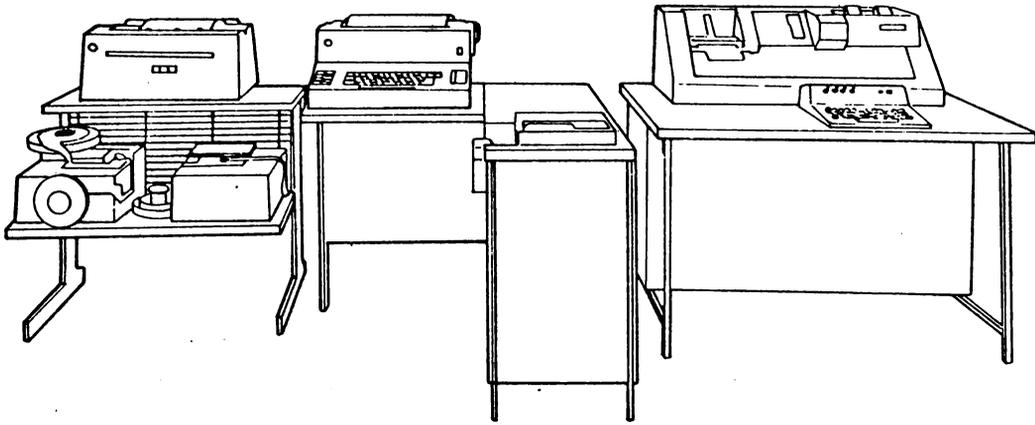
#### THE IBM COMMUNICATING MAGNETIC CARD SELECTRIC TYPEWRITER



The Communicating Magnetic Card Selectric Typewriter adds the capability of data communications to the Magnetic Card Selectric Typewriter. When the Communicating Magnetic Card Selectric Typewriter is connected to the communication channel, it can send information to or receive information from a host system. It can also be used as a standard Magnetic Card Selectric Typewriter when not connected to a communication channel.

The Communicating Magnetic Card Selectric Typewriter is an asynchronous terminal that uses the correspondence code structure for communications. It transmits and receives data at 134.5 bps.

## THE IBM 1050 DATA COMMUNICATION SYSTEM



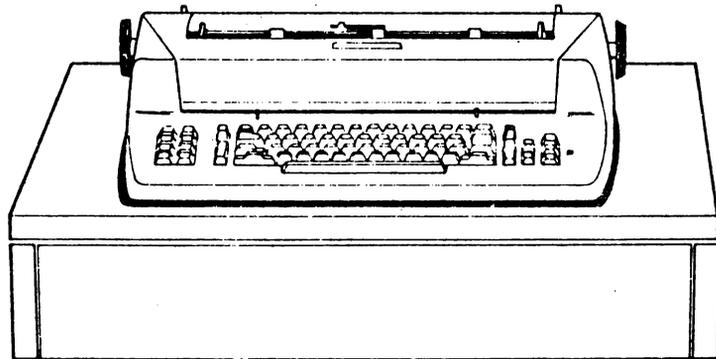
The 1050 Data Communication System can be used to:

- Enter data on a typewriter keyboard
- Print data on a typewriter printer
- Punch or read cards
- Punch or read paper tape

Data can be entered and stored on paper tape or cards for later transmission to a host or another 1050, or data received can be stored on cards or paper tape for later use.

The 1050 is an asynchronous terminal which uses either the PTTC/EBCD (perforated tape and transmission code/extended binary coded decimal) or PTTC/BCD (perforated tape and transmission code/binary coded decimal) code structure and communicates at speeds of 75 to 180 bps.

## THE IBM 2740 AND 2741 COMMUNICATION TERMINAL



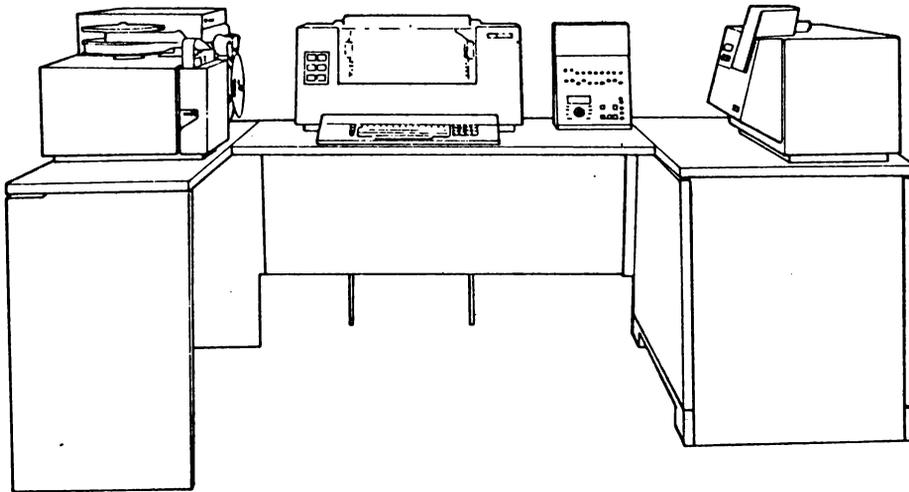
The 2740 or 2741 Communication Terminal can be used to enter data via a typewriter keyboard and print transmitted and received data on a typewriter printer.

There are two models of the 2740 – the Model 1 and the Model 2. The Model 2 has a buffer to allow faster transmission, offline data checking, and offline terminal checkout.

The 2740 and/or 2741 have the following features:

- They are both asynchronous terminals. The Model 1 can transmit and receive data at 134.5 bps. The Model 2 can transmit and receive data at 600 bps.
- They both use the PTTC/EBCD, PTTC/EBCDIC, or correspondence code structure.
- The 2741 can communicate on a switched point-to-point or a nonswitched point-to-point channel.
- The 2740 Model 1 can communicate on a point-to-point switched channel, a nonswitched point-to-point channel, or on a multipoint channel.
- The 2740 Model 2 can communicate on a nonswitched point-to-point or multipoint channel.

## THE IBM 2770 DATA COMMUNICATION SYSTEM

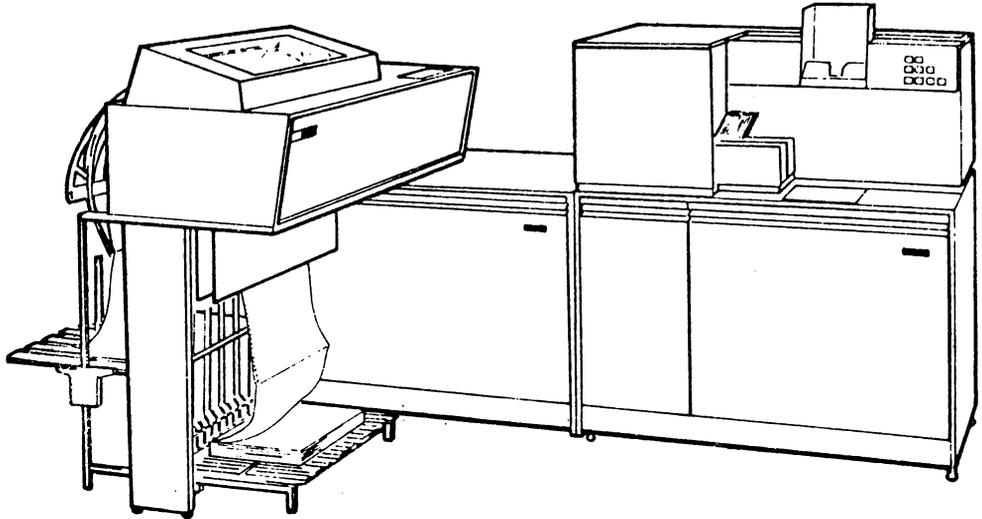


The 2770 Data Communications System can be used to transmit or receive batches of data, make inquiries, or perform a combination of both. Depending on the system configuration, the 2770 can be used to:

- Read or punch cards
- Read or punch paper tape
- Read magnetic tape
- Read magnetic character documents
- Print data
- Display data on a display station screen
- Enter data on a keyboard

The 2770 uses binary synchronous communications with either the EBCDIC or ASCII code structure and transmits data at speeds up to 7,200 bps. The 2770 can be used on point-to-point switched channels, point-to-point nonswitched channels, or multipoint channels.

## THE IBM 2780 DATA TRANSMISSION TERMINAL

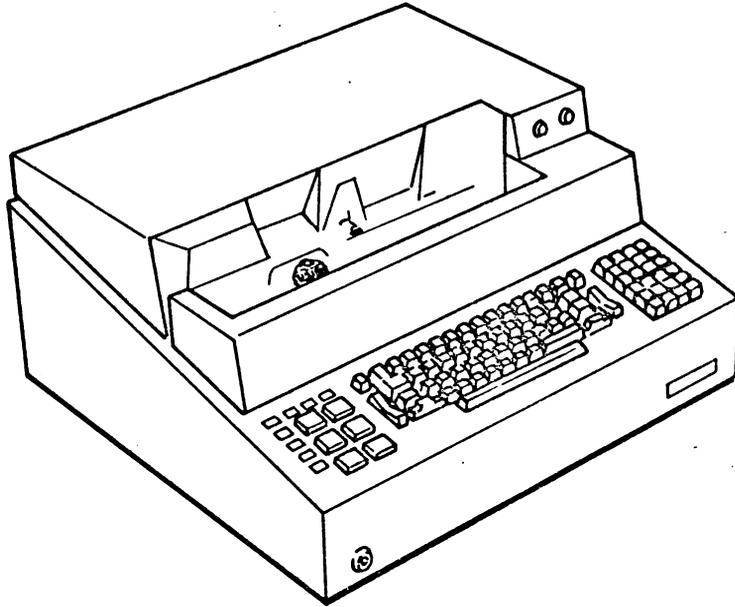


The 2780 Data Transmission Terminal can be used to transmit data from punched cards, punch received data in cards, and/or print received data. The 2780 is available in the following models:

- Model 1—Card reader and printer
- Model 2—Card reader, card punch, and printer
- Model 3—Printer only (receiving terminal only)
- Model 4—Card reader and card punch

The 2780 is a binary synchronous terminal. It uses the EBCDIC or ASCII code structure and transmits data at speeds up to 4,800 bps. The 2780 can be used on point-to-point switched channels, point-to-point nonswitched channels, or multipoint channels.

## THE IBM 2972 GENERAL BANKING TERMINAL SYSTEM



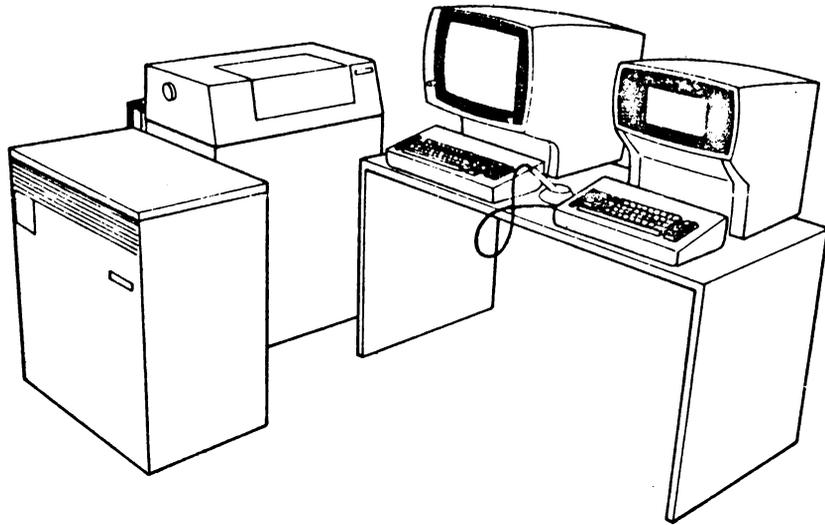
The 2972 general banking terminal system consists of the following units:

- 2972 Model 8 and Model 11 Control Stations
- 2980 Model 1 and Model 4 Teller Stations (shown in drawing)
- 2980 Model 2 Administrative Station

The 2972 can be used for general banking transaction, such as checking and savings, in a real-time system.

The 2972 is a binary synchronous terminal using the EBCDIC code structure. It can communicate on nonswitched multipoint or on nonswitched point-to-point channels at speeds up to 4,800 bps.

## THE IBM 3270 INFORMATION DISPLAY SYSTEM

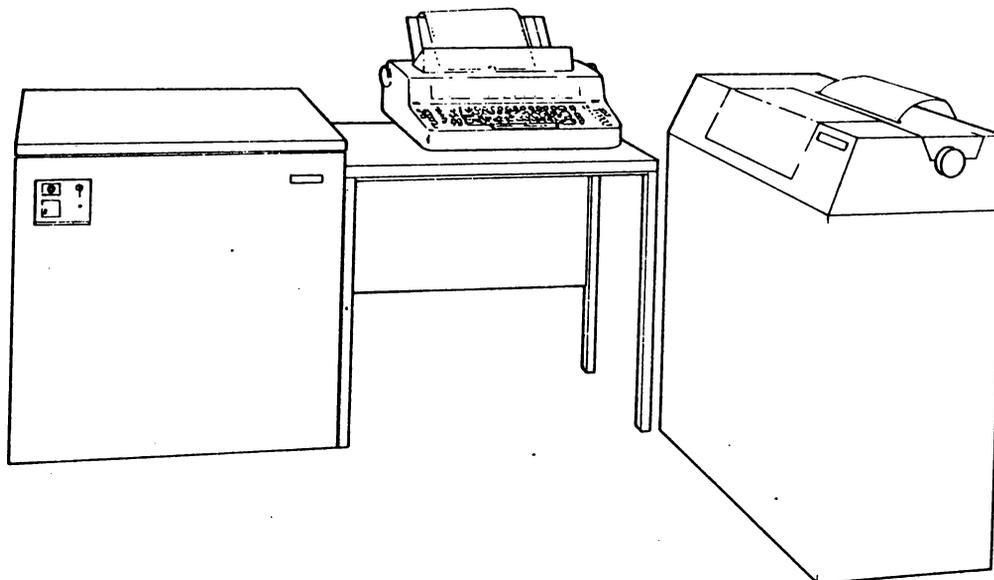


The 3270 Information Display System consists of a display station (display screen and keyboard), a printer, and a control unit. The display system offers a choice of display sizes, keyboard key layouts, and printer speeds.

The components of the 3270 are designed for many different data communication system configurations.

The 3270 uses binary synchronous communications with either the ASCII or EBCDIC code structure and transmits data at speeds up to 7,200 bps on remote channels; 1,200 bps on an internal modem. The 3270 can be used on switched point-to-point or nonswitched multipoint channels.

## THE IBM 3735 PROGRAMMABLE BUFFERED TERMINAL

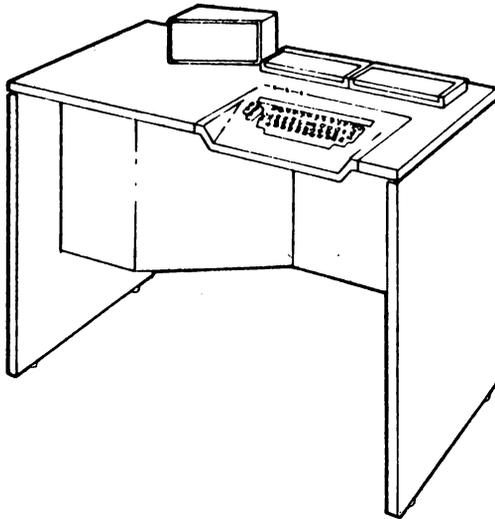


The 3735 Programmable Buffered Terminal consists of a typewriter keyboard for data entry and a typewriter printer for data output. In addition, a faster printer and a 5496 Data Recorder may be attached to the 3735.

Data is stored on disk under program control for later transmission to the host. Also, data transmitted by the host can be stored on disk for later printing or card punching by the 3735.

The 3735 is a binary synchronous terminal. It uses the EBCDIC or ASCII code structure and can transmit data at speeds up to 2,400 bps. The 3735 can use external modems or internal modems (the internal modems can transmit at speeds of 1,200 bps and 2,400 bps). The 3735 can be used on switched point-to-point channels, nonswitched point-to-point channels, or multipoint channels.

## **THE IBM 3741 DATA STATION AND THE IBM 3741 PROGRAMMABLE WORK STATION**

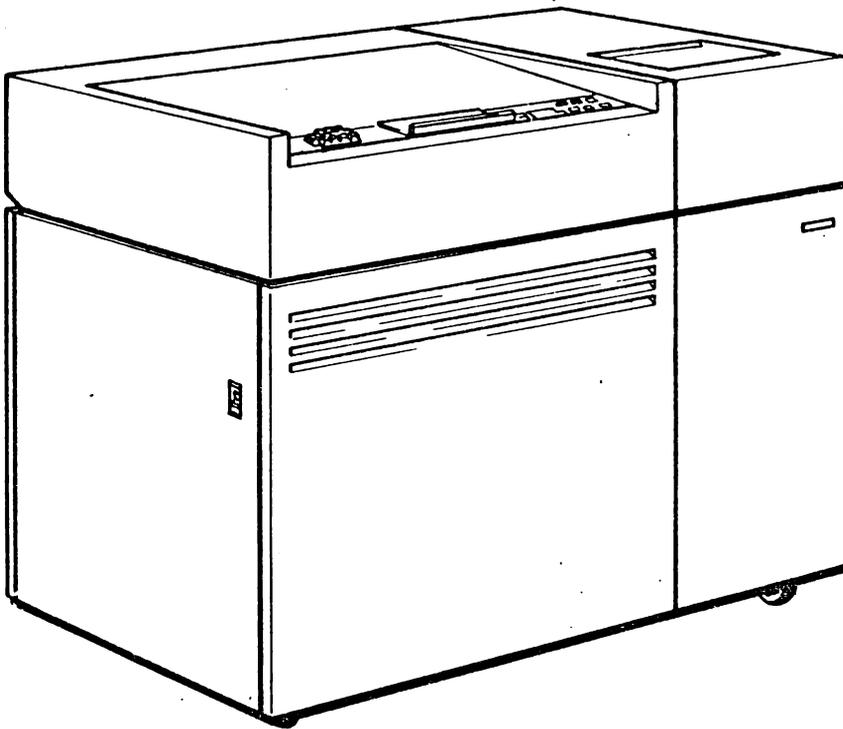


The 3741 Data Station or 3741 Programmable Work Station can be used to enter and store data on diskettes for later transmission to a host system.

The 3741 is a binary synchronous terminal that transmits and receives data at speeds of 1,200 bps using an internal modem; up to 2,400 bps using the EBCDIC code structure. It can communicate on a switched point-to-point channel or on a nonswitched point-to-point channel with another 3741, a 3747, or a host system. Expanded communication is available for transmitting blocked data.

An optional multipoint feature allows the 3741 to be used as a tributary station on a multipoint channel.

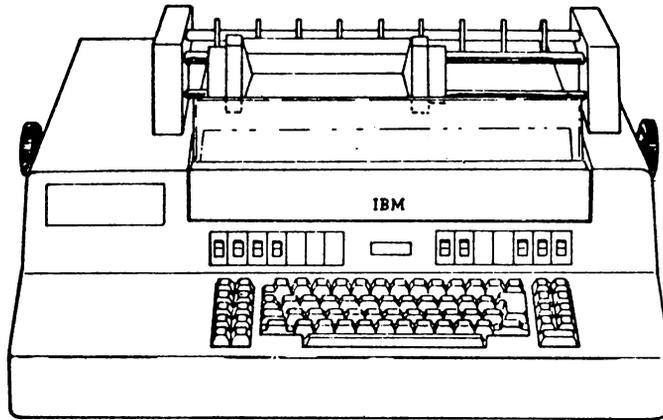
## THE IBM 3747 DATA CONVERTER



The 3747 Data Converter with the communication adapter feature can be used to enter and store data on half-inch magnetic tape for transmission to a host system.

The 3747 with the communication feature is a binary synchronous terminal that transmits and receives data at speeds up to 2,400 bps using the EBCDIC code structure (an RPQ is available for speeds up to 9,600 bps). It can communicate on a switched point-to-point channel or on a nonswitched point-to-point channel with another 3747, a 3741, or a host system.

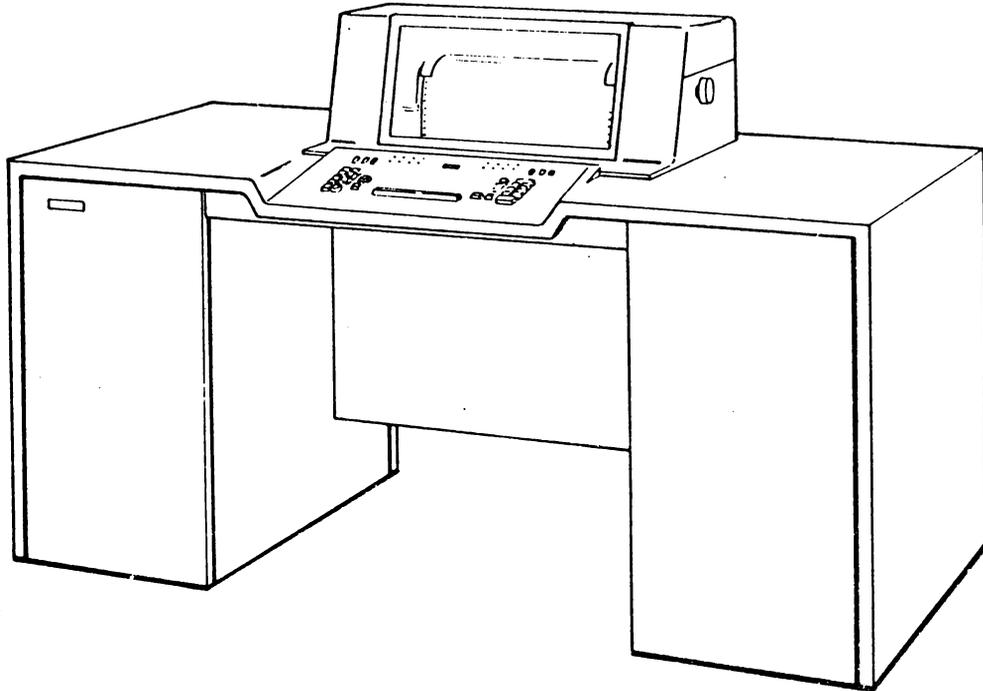
## THE IBM 3767 DATA COMMUNICATION TERMINAL



The IBM 3767 Communication Terminal is a desk-top terminal, and is available in three models to allow a selection of print speeds of 40 to 120 characters per second. The 3767 communicates with a host system via SDLC or via asynchronous communications (using a special start-stop feature).

The 3767 uses the EBCDIC or ASCII code structure with SDLC and PTTC/EBCD or correspondence code structure with the start-stop feature. The terminal can communicate at speeds up to 300 bps with asynchronous communications and up to 2,400 bps with SDLC.

## THE IBM 3770 DATA COMMUNICATION SYSTEM

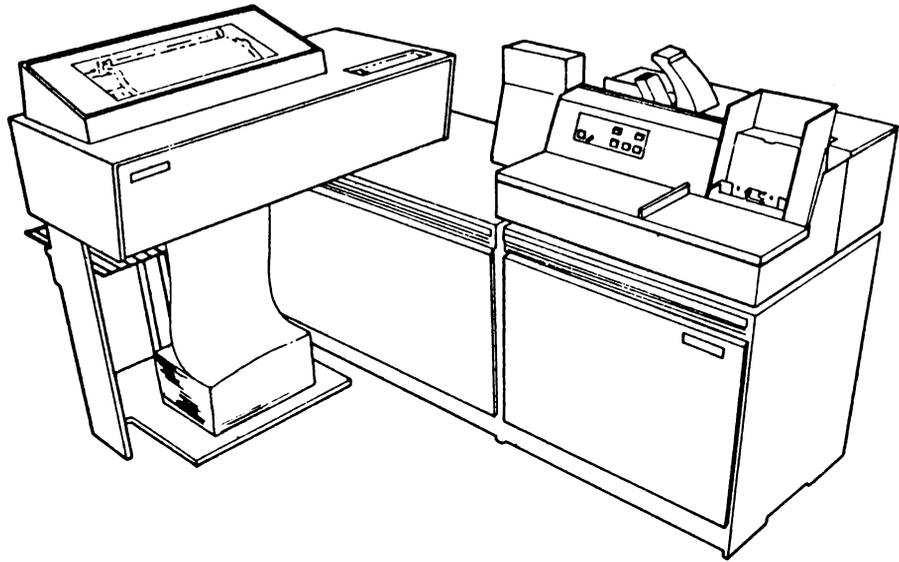


The 3770 Data Communication System offers a selection of terminals, and a selection of input and output devices and communication features as follows:

- *The 3771 Communication Terminal* is a keyboard-printer console with an optional card punch and card reader.
- *The 3773 Communication Terminal* is a keyboard-printer console and one magnetic diskette storage device.
- *The 3774 Communication Terminal* is a keyboard-printer console with an optional line printer, an optional magnetic diskette storage device, or an optional card reader and/or optional card punch.
- *The 3775 Communication Terminal* (see drawing above) is a keyboard-printer console with line printing, optional magnetic diskette storage, or an optional card reader and/or an optional card punch.
- *The 3776 Communication Terminal* is a keyboard-printer console with line printing, one or two optional diskette storage devices, and an optional card reader and/or card punch.
- *The 3777 Communication Terminal* is a keyboard terminal with high speed line printing, optional diskette storage, and an optional card reader and/or card punch.

The 3770 uses the EBCDIC or ASCII code structure with binary synchronous communications or synchronous data link control. Communications can be via multipoint channels, point-to-point switched channels, or point-to-point nonswitched channels at data transmission speeds up to 4,800 bps; the 3777 can communicate at speeds up to 9,600 bps.

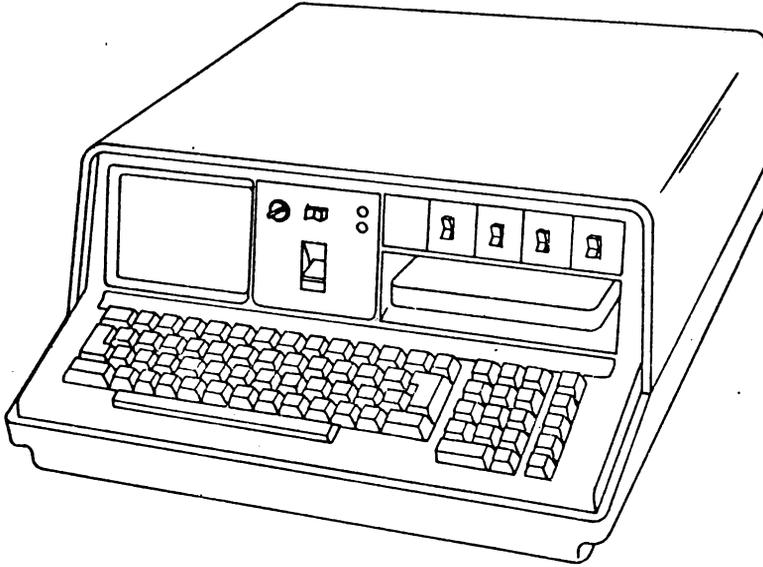
## THE IBM 3780 COMMUNICATIONS TERMINAL



The 3780 Communications Terminal consists of a card reader, a card punch, and a printer.

The 3780 uses binary synchronous communications and can transmit or receive data on a switched point-to-point channel or on a nonswitched point-to-point channel or multipoint channel. The 3780 can use either the EBCDIC or the ASCII transmission code structure and can transmit at speeds up to 7,200 bps.

## THE IBM 5100 AND 5110 WITH ASYNCHRONOUS COMMUNICATIONS



The 5100 Computer with the expansion feature and the communications adapter feature or ASCII communications RPQ installed, and the IBM 5110 with the asynchronous communications feature installed function as communication terminals. The terminals can be used to:

- Enter data from the keyboard
- Transmit data from the tape units to a host system
- Write on tape, data that is transmitted to, or received from a host system
- Print the data that is transmitted to a host system and/or received from a host system

The 5100 and the 5110 are asynchronous terminals that can communicate with a host system on a half-duplex switched point-to-point or a nonswitched point-to-point channel (a duplex channel is required).

With asynchronous communications the 5100 and 5110 transmit data at 134.5 or 300 bps using the PTTC/ERCD or correspondence transmission code structures.

With the ASCII communications RPQ, the 5100 and 5110 communicate with a host at 110, 150, or 300 bps using the ASCII code structure.

## THE IBM 5110 WITH BINARY SYNCHRONOUS COMMUNICATIONS

The 5110 Binary Synchronous Communications Feature allows the 5110 to be used as a terminal to communicate with host systems or other terminals that are equipped with binary synchronous communications. With this feature installed, the 5110 (with the IBM-supplied APL or BASIC BSC Customer Support functions or a user-written APL or BASIC program) can be used to:

- Transmit data from the display screen.
- Transmit data from tape or diskette.
- Display received data.
- Print received data.
- Write received data on tape or diskette.

The 5110 can communicate on a switched point-to-point channel, a non-switched point-to-point channel, or a nonswitched multipoint channel as a tributary station. The 5110 transmits and receives data at up to 4,800 bps.

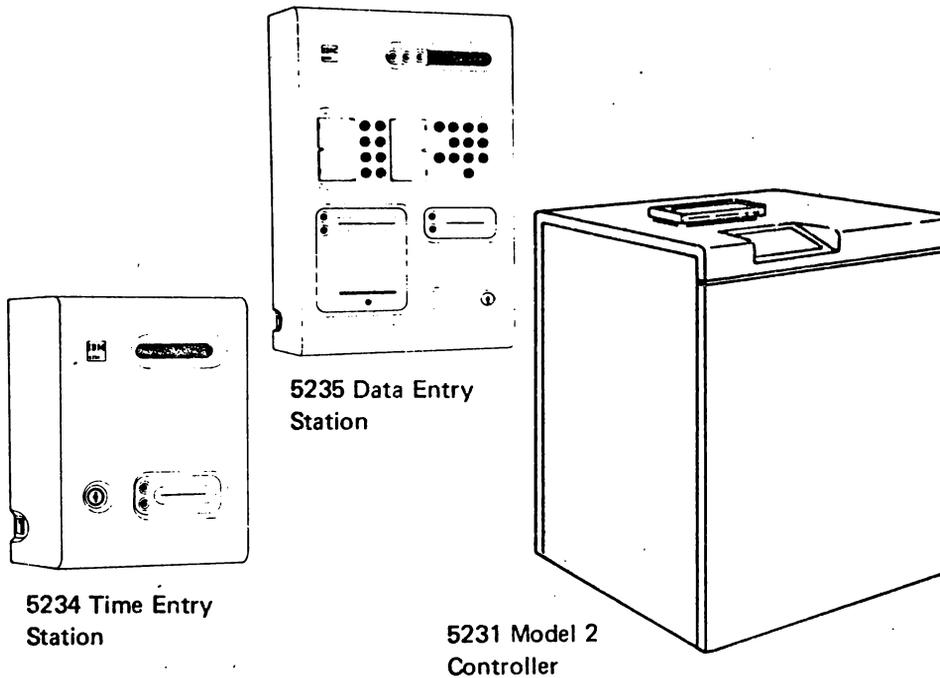
Other features available for the 5110 with the binary synchronous communications feature are:

- A 1,200 bps integrated modem that can include a switched network backup feature with automatic answering of calls.
- An EIA RS-232C or CCITT V.24-V.28 interface adapter to attach external modems.
- A Data-Phone<sup>1</sup> Digital Service Adapter (DDSA) that allows you to attach the 5110 to the AT&T Data-Phone digital service network.

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<sup>1</sup>Trademark of the American Telephone & Telegraph Co.

## THE IBM 5230 DATA COLLECTION SYSTEM

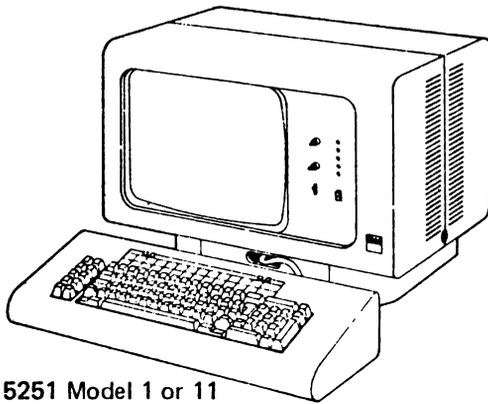


The IBM 5230 Data Collection System can be used to enter data at entry stations located at work areas. The 5234 Time Entry Station is for badge entry only; the 5235 Data Entry Station accepts data from cards, keyboard, and badges. The entry stations are attached to the 5231 controller.

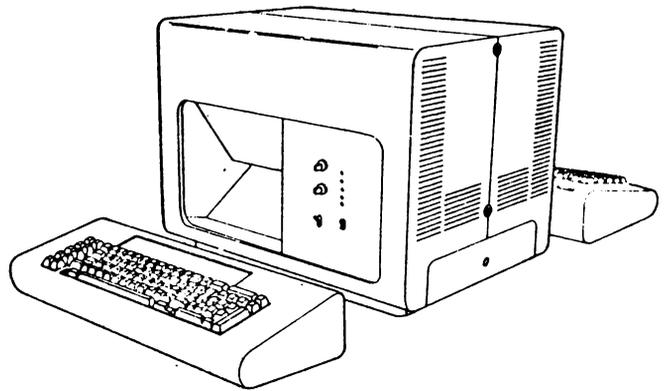
The 5231 Model 2 Controller communicates with a host system as a binary synchronous terminal. It uses EBCDIC code structure in nontransparent mode and can transmit data at speeds up to 4,800 bps. The 5230 Data Collection System can be used on switched point-to-point channels, nonswitched point-to-point channels, or multipoint channels.

Data can be transmitted to the host when received from the entry stations or can be stored on diskette for later transmission to the host.

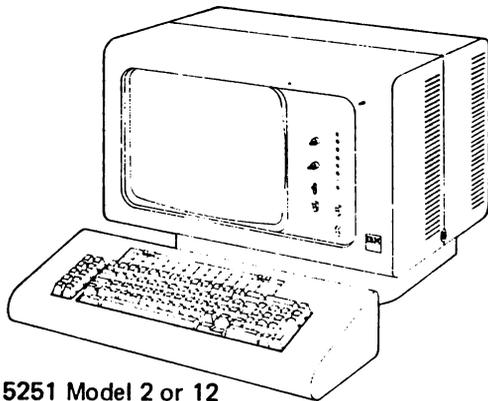
## THE IBM 5250 INFORMATION DISPLAY SYSTEM



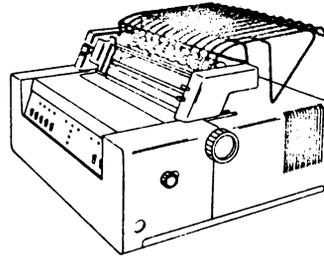
**5251 Model 1 or 11  
Display Station**



**5252 Dual Display Station**



**5251 Model 2 or 12  
Display Station**



**5256 Printer**

The IBM 5250 Information Display System is a family of keyboard/display and printer work stations. The 5250 consists of the following devices and features:

- 5251 Display Station in four models:
  - Model 1 is a directly attached work station with a 960-character display.
  - Model 2 is a remote communicating work station with a 960-character display.
  - Model 11 is a directly attached work station with a 1,920-character display.
  - Model 12 is a remote communicating work station with a 1,920-character display.

- 5252 Dual Display Station

The 5252 Dual Display Station consists of two movable keyboards that are connected by a short cable to a common display unit. This display unit is divided logically and optically into two independent work stations, that allows each operator to view a separate 960-character display unit.

- 5256 Printer in three models:
  - Model 1 prints at a maximum rate of 40 characters per second.
  - Model 2 prints at a maximum rate of 80 characters per second.
  - Model 3 prints at a maximum rate of 120 characters per second.

The 5251 Models 2 and 12 Display Stations serve as the work station controller for attached 5251 Models 1 and 11, 5252 Dual Display Station or the 5256 Printer when the CF (cluster feature) is installed. The 5250 Information Display System can use the 5256 Printer to print information that is displayed at the 5251 or 5252 display station, or output that comes from a system program. The printer attaches directly to a System/34 or a 5251 Model 2 or 12 Display Station with a cluster feature.

Other features provided by the 5250 Information Display System are:

- Cluster feature

The cluster feature allows direct attachment of a 5256 Printer, a 5251 Model 1 or 5251 Model 11 Display Station, or a 5252 Dual Display Station to the 5251 Model 2 or 12. The cluster feature provides four cable connections and allows the attachment of up to four work stations.

- Dual cluster feature

The dual cluster feature allows the same attachment as the cluster feature, however, the dual cluster feature provides eight cable connections and allows up to eight work stations to be attached.

- Internal clock communications feature

The internal clock provides clocking of the data onto and off the communications channel at 1,200 bps. This feature is required only when the attached modem does not provide its own clocking.

- Data-Phone Digital Service Adapter (DDSA)

The DDSA allows the 5251 Model 2 or 12 to be connected to an AT&T nonswitched Data-Phone Digital Service Network. The digital network allows the Model 2 or 12 to communicate at data rates of 2,400, 4,800 or 9,600 bps.

- **EIA interface**

The EIA interface allows the 5251 Model 2 or 12 to be attached to an external modem and meets the EIA standard RS-232C characteristics.

- **Integrated modems**

The 5251 Model 2 or 12 offer two 1,200 bps integrated modems:

- Nonswitched
- Switched with manual answer

The modems connect the Model 2 or 12 to either a customer owned communications channel or to a common-carrier-provided switched or nonswitched communications line. When operating on a switched common carrier channel, the 1,200 bps integrated modem is connected to a data access arrangement. Attachment to a nonswitched facility is via an IBM-supplied cable directly to the line. Integrated modems require the internal clock feature.

## Chapter 7. Using GSD Products with Communications

This chapter describes some of the uses for GSD products and other related IBM products with data communications. Communication programs provided for GSD systems are described briefly followed by sample configurations showing how hardware, programming, and data communications facilities are related in a total system.

### THE IBM SERIES/1

With data communications, the Series/1 can be used as a host system, a subhost system, or a processor terminal. With its associated disk storage, peripherals, integrated communications features, programmable communications subsystem, and broad range of programming support, it can be used in the following application areas:

- Concentrator
- Front-end processor
- Message switching
- Distributed host support – data entry
- Distributed processing (host dependent)
- Distributed processing (stand alone)
- Remote job entry

The following communications programs are available to the Series/1 user to allow communication with terminals, other systems, or both:

- Series/1 Realtime Programming System
- Series/1 Programmable Communications Subsystem Preparation Facility
- Series/1 Programmable Communications Subsystem Execution Support
- Series/1 Remote Job Entry (PRPQ)
- Series/1 Intelligent Terminal Subsystem (FDP)
- Series/1 Binary Synchronous Communications Control Program Support (PRPQ)
- Control Program Support Autocall Support (PRPQ)

## **The Series/1 Realtime Programming System**

With the realtime programming system the user can send or receive data using asynchronous, binary synchronous or synchronous data link control protocols between the Series/1 and remote stations. A remote station is either a terminal or another computer. The communications support provided by the realtime programming system handles point-to-point connections both switched and nonswitched. The communications portion of the operating system has the following functions:

- Establishes, terminates, and controls access between the user programs and remote stations.
- Transfers data between the user programs and remote stations.
- Provides translation services from one transmission code to another.
- Provides error recovery and diagnostic support.

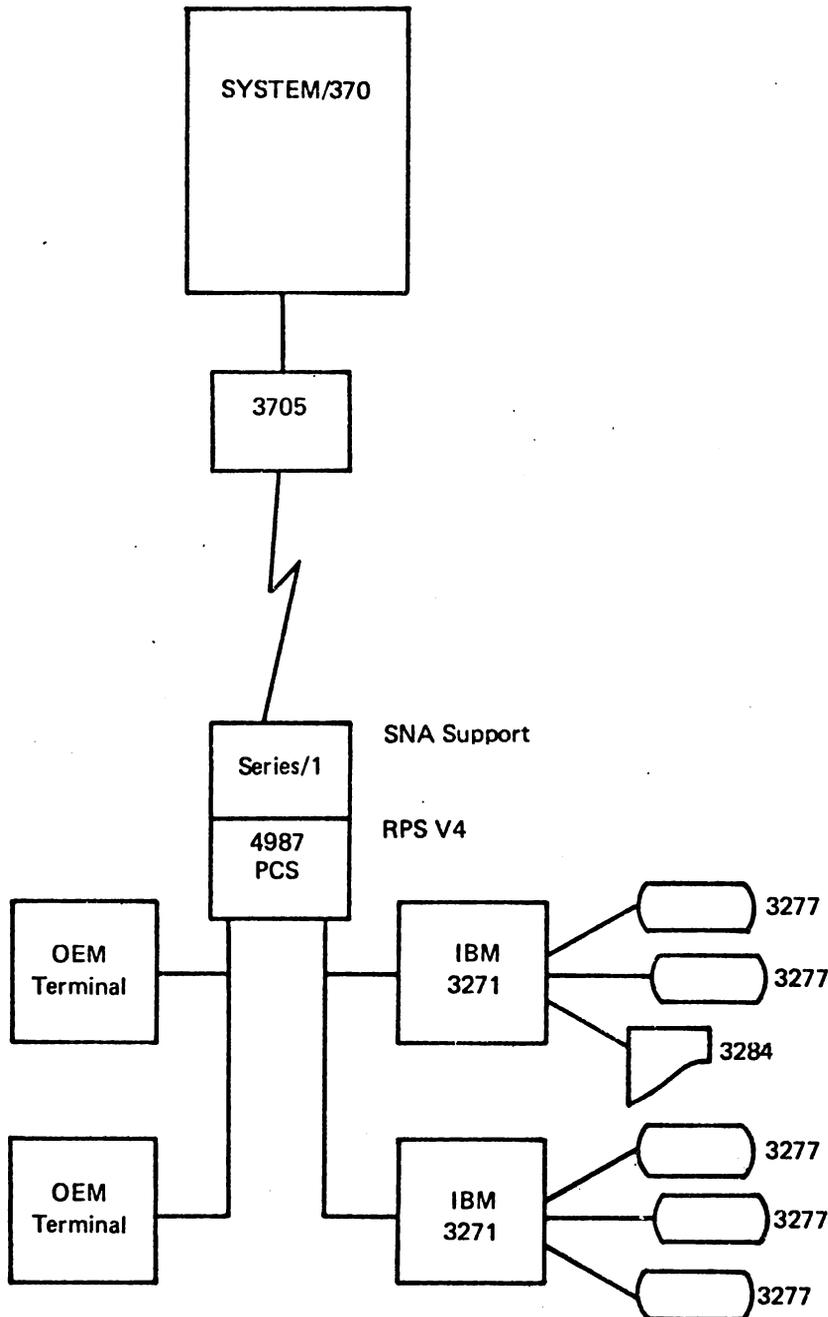
The following communications I/O operations are supported (as appropriate to the protocol being used):

- Receive only
- Transmit only
- Transmit interspersed with receive
- Transmit with conversational reply
- Receive with conversational reply
- Transmit delay
- Transmit EOT (end of transmission)
- Transmit acknowledgment
- Transmit interrupt

The realtime programming system SNA supports controls for the Series/1 user, the management of sessions, and the flow of data in an SNA network between a user program in the System/370 host and a user program in the Series/1. This support provides the following features:

- System definition services
- Network attachment activation/deactivation services
- Session and message exchange services
- Activation of a Series/1 task set from the host
- SDLC secondary station support
- SNA physical unit type support
- SNA function management profile 4 support
- SNA transmission services profile 4 support

The realtime programming system provides a data flow control level interface on an SNA network and provides for support as a multiple logical unit cluster controller. A System/370 using OS/VS2 (SVS or MVS) and ACF/VTAM or ACF/TCAM controls the network. The realtime programming system allows multiple Series/1 user programs to be in session with multiple System/370 user programs.



This configuration shows a Series/1 using SNA/SDLC upline to a System/370 with down line support of IBM and OEM Terminals.

## **IBM Series/1 Programmable Communications Subsystem Preparation Facility**

The IBM Series/1 Programmable Communications Subsystem Preparation Facility is a macro library that is used to support the generation of controller storage image programs for the IBM Series/1 Programmable Communications Subsystem. This macro library is used with either the IBM Series/1 Base Program Preparation Facility or the IBM Series/1 Program Preparation Subsystem.

This macro library support provides the following features:

- The ability to define and customize the total protocol for a subsystem
- Communications instructions for implementing communications applications via:
  - Communications macroinstructions
  - Communications definition macros
- Output of macros after assembly are linked to create the controller storage image load module

## **IBM Series/1 Programmable Communications Subsystem Execution Support**

The IBM Series/1 Programmable Communications Subsystem Execution Support is controlled by the Series/1 Realtime Programming System and provides support for the IBM Series/1 Programmable Communications Subsystem. The support consists of a loader and macros that enhance the EXIO commands in the realtime program system for operation with a 4987.

This support feature provides a loader to load the controller storage image load module (created by the IBM Programmable Communications Subsystem Preparation Facility Support) into the subsystem controller storage online. The loader may be initiated from the operator console or from the user's program and executed in a user partition as a user task set. The loader feature provides the following functions:

- Verifies that the subsystem can be loaded by executing internal diagnostics
- Reads the user's controller storage image program from disk or diskette

## **IBM Series/1 Remote Job Entry (PRPQ)**

Series/1 Remote Job Entry (RJE) provides the Series/1 realtime programming system user the ability to transmit jobs and receive their output from a host System/370 having OS/VS2 and JES/2 installed.

Remote Job Entry provides the following features:

- Connection via a point-to-point (switched or nonswitched) binary synchronous line
- Output to a printer or disk/diskette
- Series/1 command syntax checking
- Supports blank compression/expansion
- RJE session statistics
- Logging to history file of RJE session information

## **Binary Synchronous Communications Control Program Support (PRPQ)**

The binary synchronous communications control program support product is an extension to the control program support and provides the user support for the IBM 2074, 2075, and 2093/2094 communications features.

The binary synchronous communications control program support provides the following features:

- Read/write level support with transparency
- Auto-answer
- Trace facilities
- Point-to-point communications
- Error logging to disk/diskette

The IBM 4953 and IBM 4955 appear as a System/3 to other stations in the network.

## **Control Program Support Auto-Call Support (PRPQ)**

The control program support auto-call support (PRPQ) provides a set of functional modules to be used in conjunction with control program support for the support of the auto-call originate hardware RPO.

## **IBM Series/1 Intelligent Terminal Subsystem (FDP)**

The Series/1 Intelligent Terminal Subsystem provides a means of communication to host processors over binary synchronous lines using 3270 protocol. Emulation of multiple 3270 subsystems results in increased efficiency and flexibility of terminal work stations by freeing the user from dedicated mode to program switchable mode. The Series/1 Intelligent Terminal Subsystem is a productivity aid and provides a base architecture for local programming capability and distributed data processing support of the 3271/3277 protocol. A connection to existing host applications using the 3270 protocol is made.

The Series/1 Intelligent Terminal Subsystem is used with the IBM Series/1 Control Program Support (PRPQ) and the IBM Series/1 Binary Synchronous Control Program Support (PRPQ) to provide the following functions:

- Provides emulation of 3271 Model 2 Control Unit
  - Emulates one or more control units concurrently
  - Allows concurrent sessions with multiple host systems
  - Allows access to more than one data base system for inquiry and/or update
  - Provides a logical and concurrent connection from each display station to multiple BSC lines
- Provides emulation of 3277 Model 2 display stations
  - Provides a standard network interface for non-3277 devices
  - Emulates multiple 3277s on both the 4979 display station and the new 4978 display station
  - Emulates 3277 function keys by special character commands on the 4979 display station
  - Supports user invoked save and restore of local function key reassignment for the 4978 display station
  - Provides macroinstructions for local screen definition
- Provides emulation of 3286 Printer (screen image only)
  - Supports printing of screen image to a 4974 Serial Printer
  - Provides printer spooling of screen contents

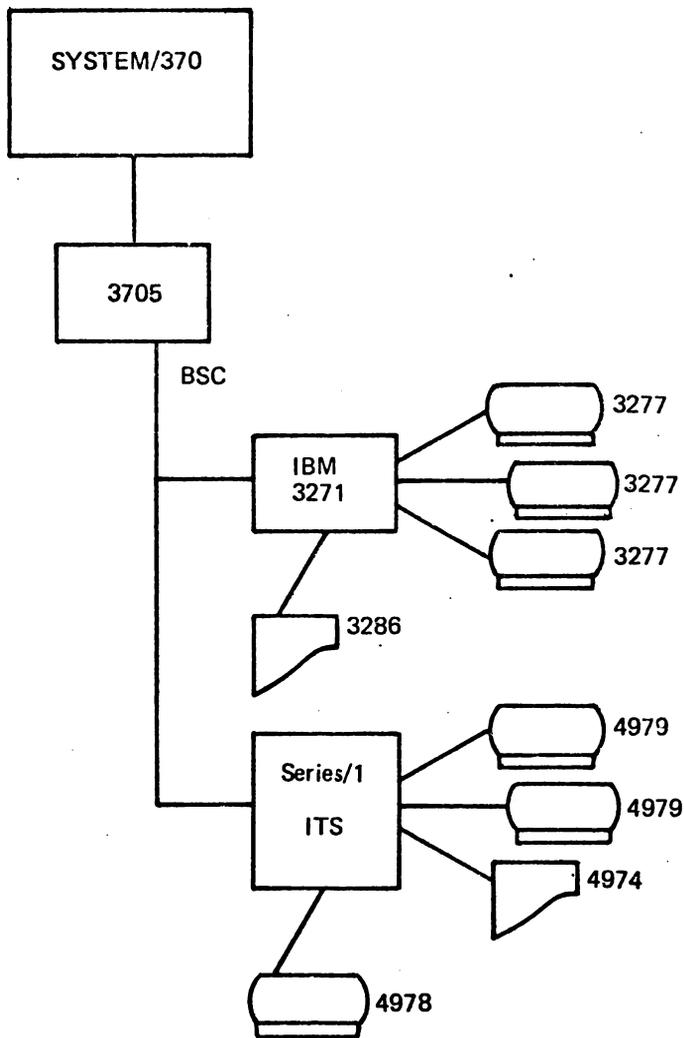
- Provides system management functions

One display station can be designated as a *master console*

- Master console support displays:

- Terminal status (local or remote line number)
- Mean terminal response time
- BSC line status (active or offline)
- Communication traffic management statistics
- Storage manager statistics
  - Each station attached can display a menu of selectable functions.
  - Storage manager dynamically allocates storage in support of BSC lines, displays and printer.
  - It provides capability to add user-written code for distributed processing functions.

- Provides local tabbing at each terminal



The preceding configuration shows a Series/1 using ITS PRPQ to emulate a 3270 Terminal System to an IBM System/370.

## **THE IBM SYSTEM/3**

With data communications, the System/3 can be used as a host system, a subhost system, a processor terminal, or an RJE or MRJE work station. The following communication programs are provided for the System/3 to allow it to communicate with terminals, other systems, or both.

- The RPG II telecommunications feature for all System/3 models
- The RPG II 3270 display control feature for all System/3 models except the Model 6
- The Data/3 program product for System/3 Models 8, 10 Disk, 12, and 15
- The communications control program (CCP) feature for System/3 Models 4, 8, 10 Disk, 12, and 15
- The terminal query facility (TQF/3) PRPQ for System/3 Models 10 Disk, 12, and 15
- The BSCA multiline/multipoint (MLMP) feature for System/3 Models 8, 10 Disk, 12, and 15
- The multiple line terminal adapter input/output control system (MLTA IOCS) RPQ for System/3 Models 10 Disk, 12, and 15
- The remote job entry work station (RJE/WS) feature for System/3 Models 8 and 10
- The MULTI-LEAVING remote job entry work station feature (MRJE/WS) for all System/3 models

## **The RPG II Telecommunications Feature**

With the RPG II telecommunications feature, a System/3 user can send or receive data using binary synchronous communications. A special RPG II coding sheet is available to code the communication portion of the program that permits the System/3 to:

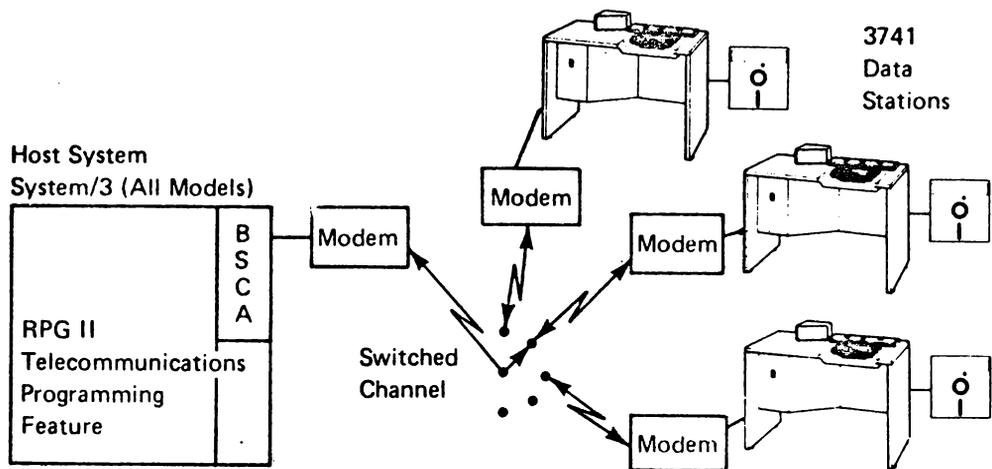
- Receive only
- Transmit only
- Receive with conversational reply
- Transmit with conversational reply
- Alternately transmit and receive

The following BSCA features, options, and capabilities are supported by the RPG II telecommunications feature:

- Manual call and manual answer
- Automatic calling and automatic answering
- Medium and high speed data transmission rates
- Station selection
- EBCDIC or ASCII code structure and EBCDIC transparency

A System/3 with RPG II telecommunications can communicate via point-to-point switched channels, point-to-point nonswitched channels, or a multipoint channel as a tributary station.

In the following configuration, the System/3 is a host system to 3741 data stations via switched channels using the BSCA (binary synchronous communications adapter) and the RPG II telecommunications feature:



The System/3 may also communicate with another System/3, a System/32, or other binary synchronous systems or terminals as either a host or a processor terminal.

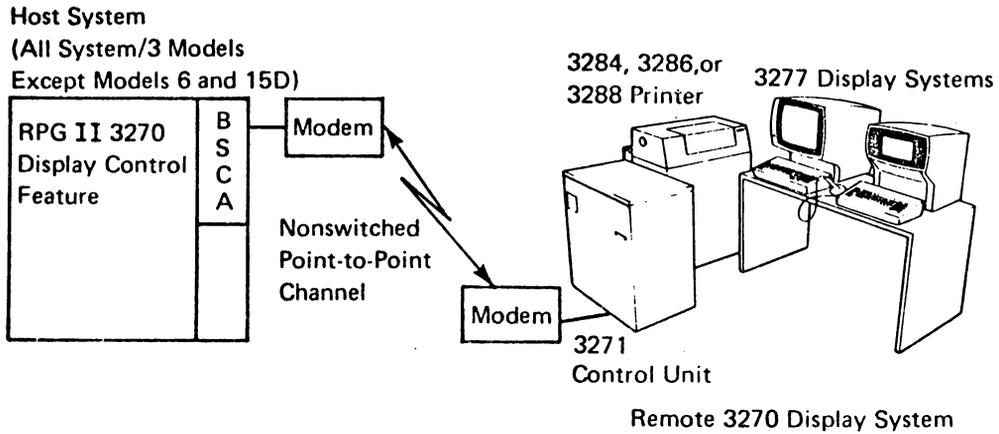
### The RPG II 3270 Display Control Feature

The RPG II 3270 display control feature allows binary synchronous communications between a System/3 as a host system and local or remote 3270 devices. This programming feature provides:

- Automatic buffering and queuing of terminal data
- Display formatting that permits RPG II to support 3270 devices
- Complete data link control
- The capability to attach up to 18 terminals (maximum number of terminals depends on System/3 model)
- The capability to code more than one application within one program

With minor changes an RPG II program used with this feature can be recompiled to run under control of the communications control program (CCP), provided the RPG II program meets CCP requirements.

The following configuration shows a System/3 attached to remote 3270 devices via the BSCA and a nonswitched channel using the RPG II 3270 display control feature:

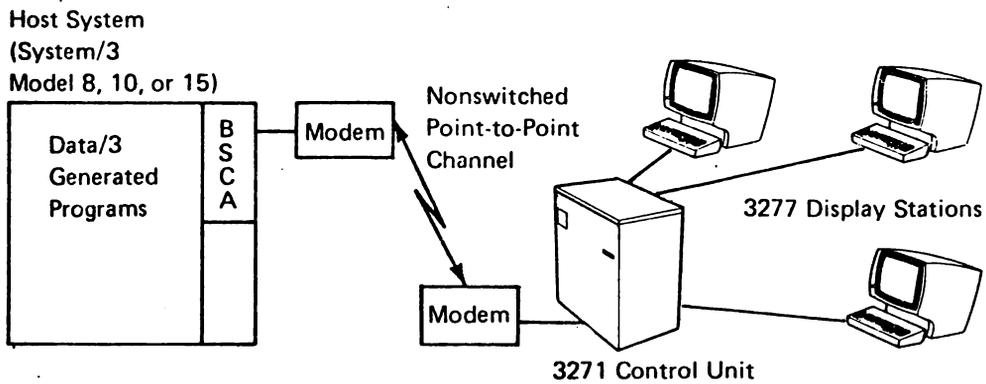


### The Data/3 Program Product

The Data/3 program product allows binary synchronous communications between a System/3 as a host system and a 3270 Display System. With Data/3, a System/3 user can generate programs to enter data into System/3 files, inquire into System/3 files, and update System/3 files. Programs are generated using special forms to define the program and describe the data.

Data/3 generated programs run under control of the System/3 system control program or the CCP.

The following example shows a System/3 attached to a remote 3270 Display System via a nonswitched channel and the BSCA using Data/3 generated programs:



## **The Communications Control Program**

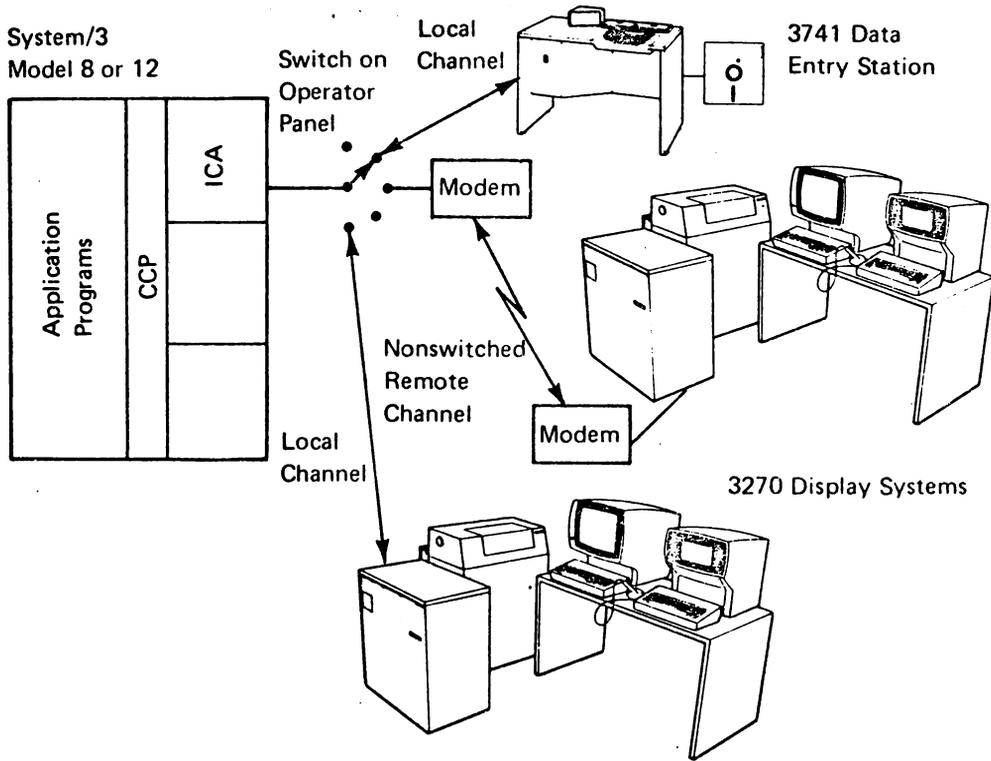
The communications control program provides communication functions for the System/3. The program allows the System/3 to communicate with terminals and other systems as a host or a subhost system. It allows terminals to use a set of System/3 application programs and permits the application programs to access a number of System/3 disk files.

CCP relieves programmers of most of the communication control programming when establishing a communication system. Some of the functions performed by the communications control program are:

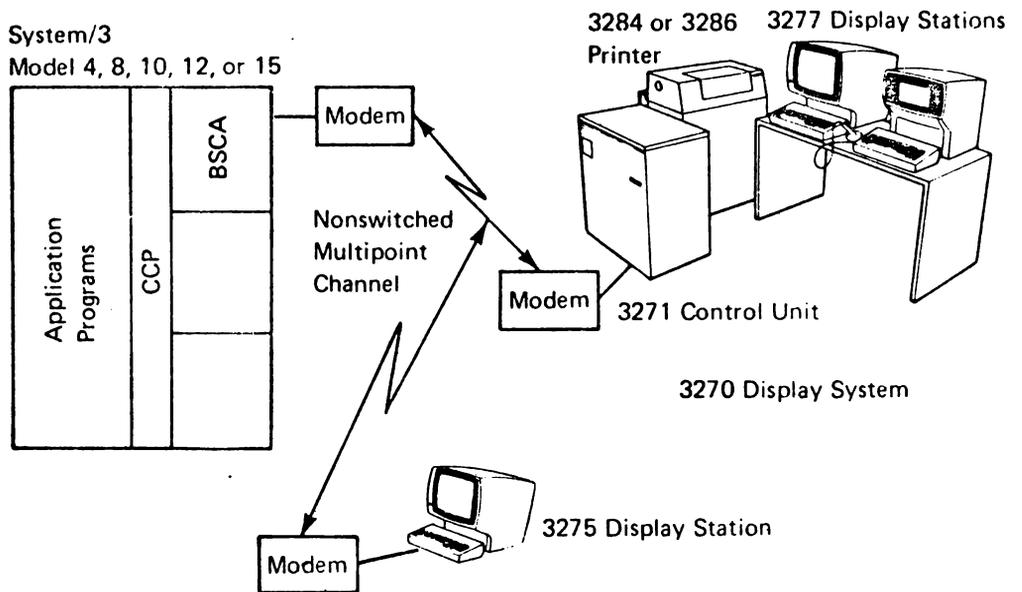
- It monitors the terminals for program requests or system commands.
- It allows a terminal or system operator to initiate the loading and execution of an application program.
- It manages the resources of the communication system and makes them available, as required, to the application programs.
- It allows several application programs for different terminals to run concurrently. (The number of programs depends on System/3 model and storage capacity.)
- It allows application programs to share disk files and protects the files against erroneous results that might be caused by conflicting accesses.

The following sample configurations show how the System/3 can be used for communications using the communications control program, and the communication adapters that are provided for the System/3.

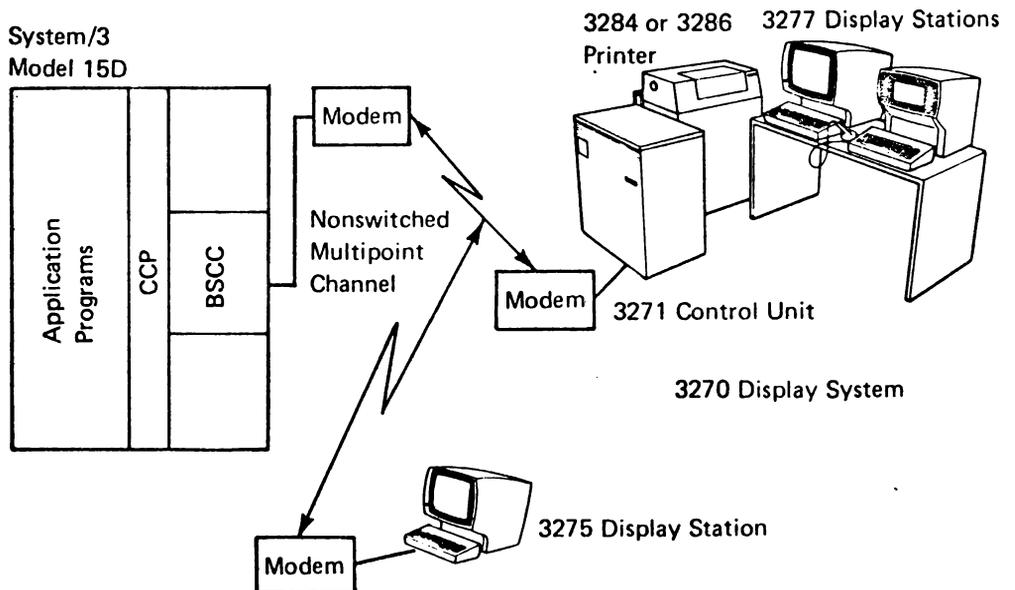
The following configuration shows the System/3 as a host to local and remote binary synchronous devices using the integrated communications adapter (ICA) on the Model 8, or Model 12:



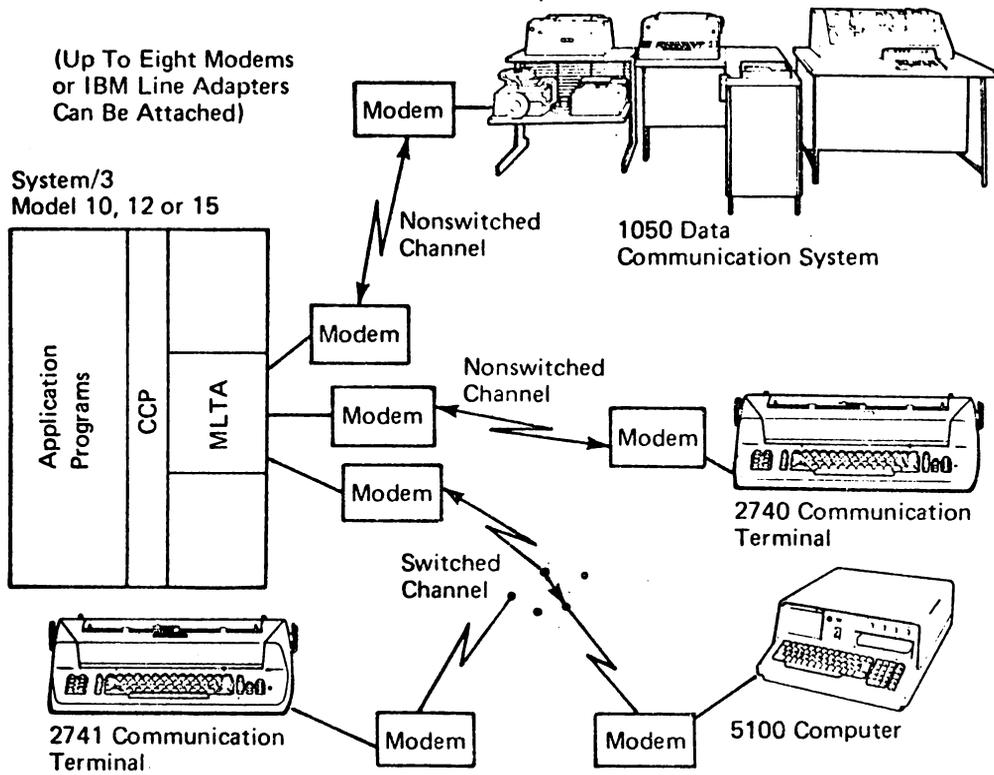
The following configuration shows the System/3 as a host to remote 3270 devices using the binary synchronous communications adapter (BSCA) on the System/3 Model 4, 8, 10 Disk, 12, or Model 15:



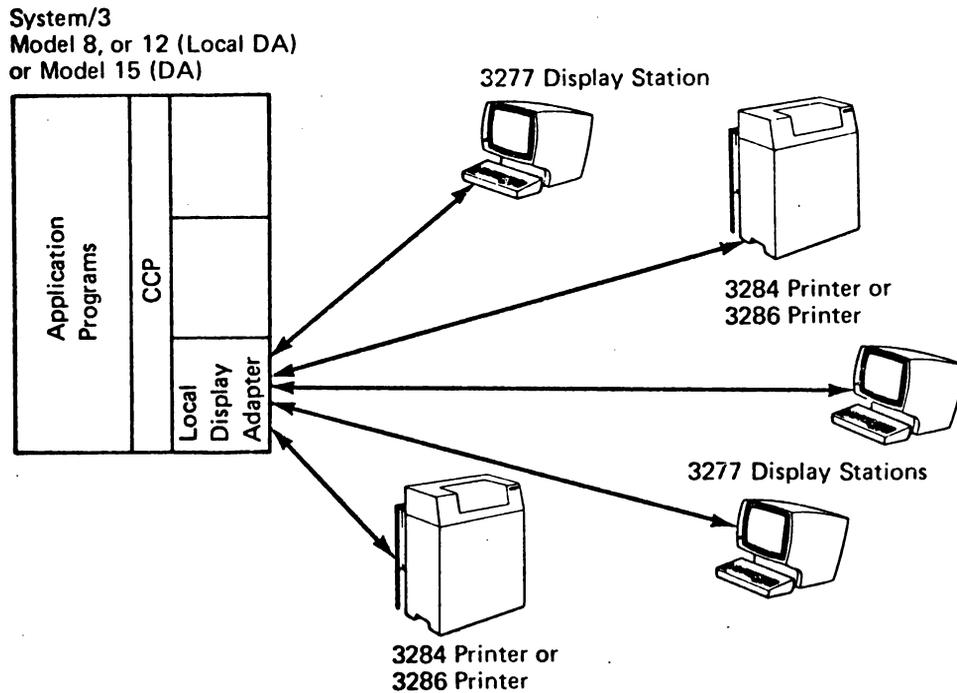
The following configuration shows the System/3 as a host to remote 3270 devices using the binary synchronous communications control (BSCC) on the System/3 Model 15D:



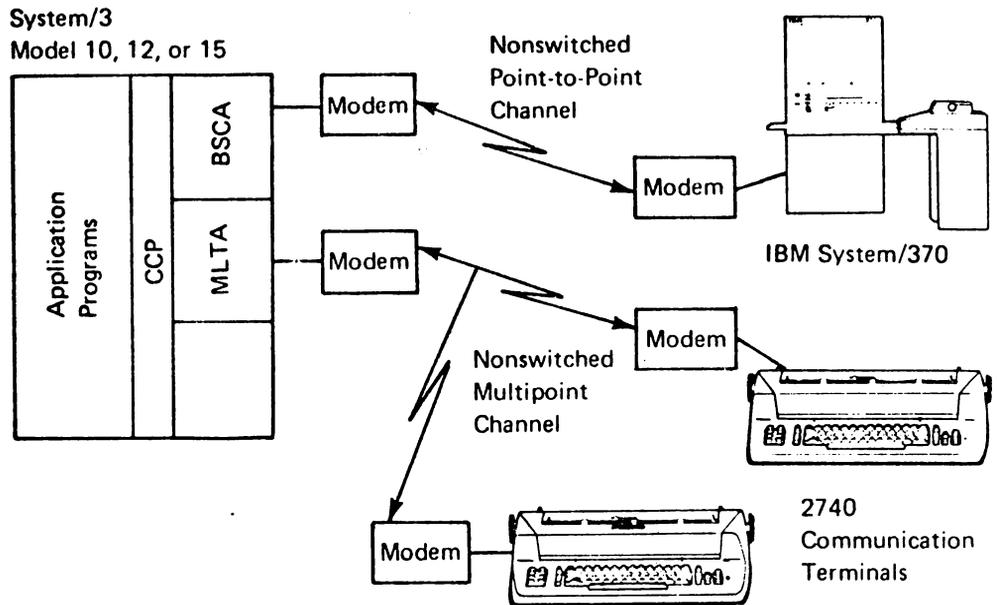
In the following configuration, the System/3 is a host to remote asynchronous (start-stop) devices using the multiple line terminal adapter (MLTA):



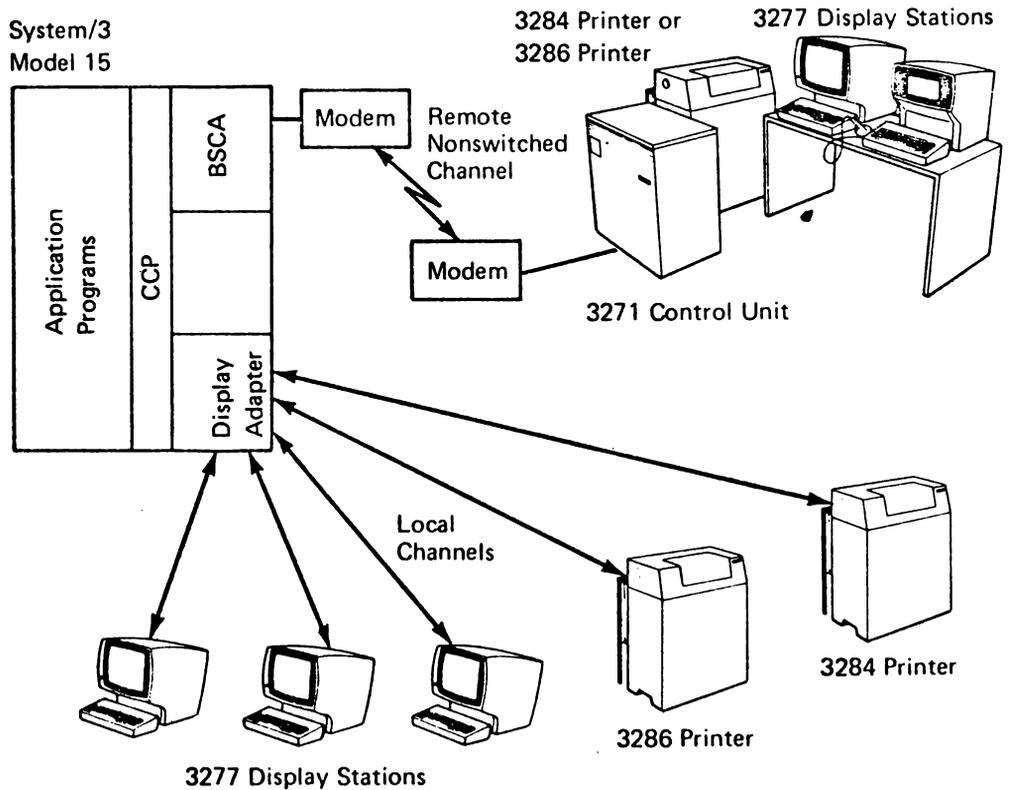
In the following configuration, the System/3 is a host system to local 3270 devices using the local display adapter (local DA) or the display adapter (DA):



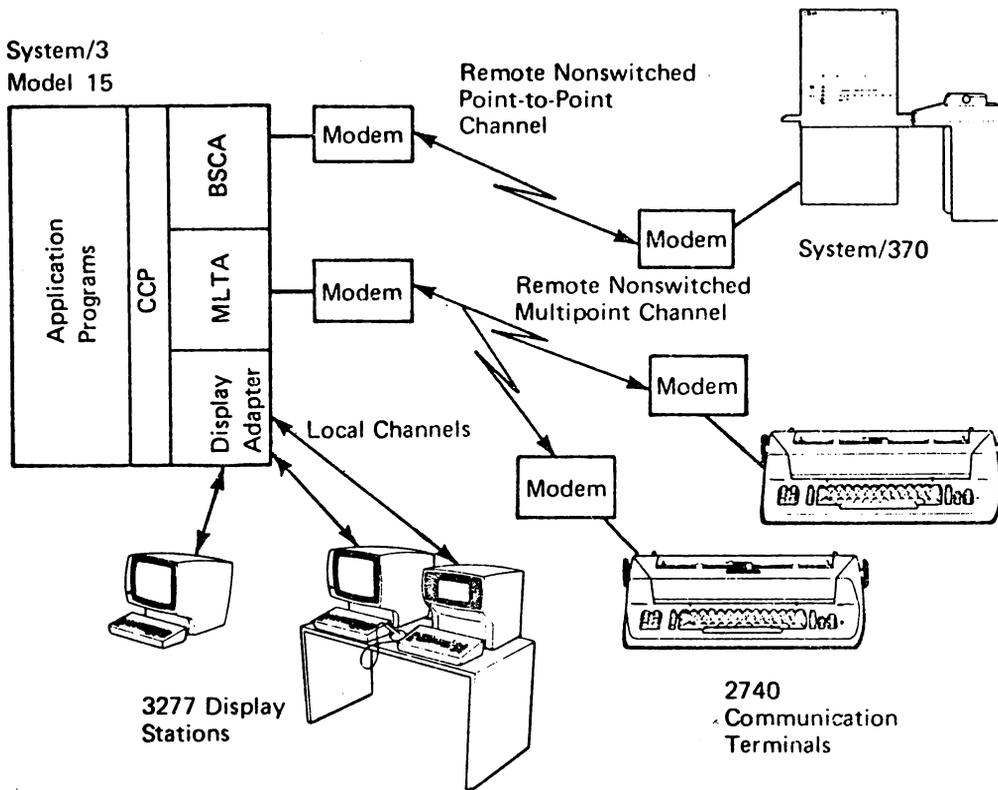
The System/3 in this configuration is a subhost with asynchronous (start-stop) terminals using the multiple line terminal adapter (MLTA) and a remote System/370 host system using the binary synchronous communications adapter (BSCA):



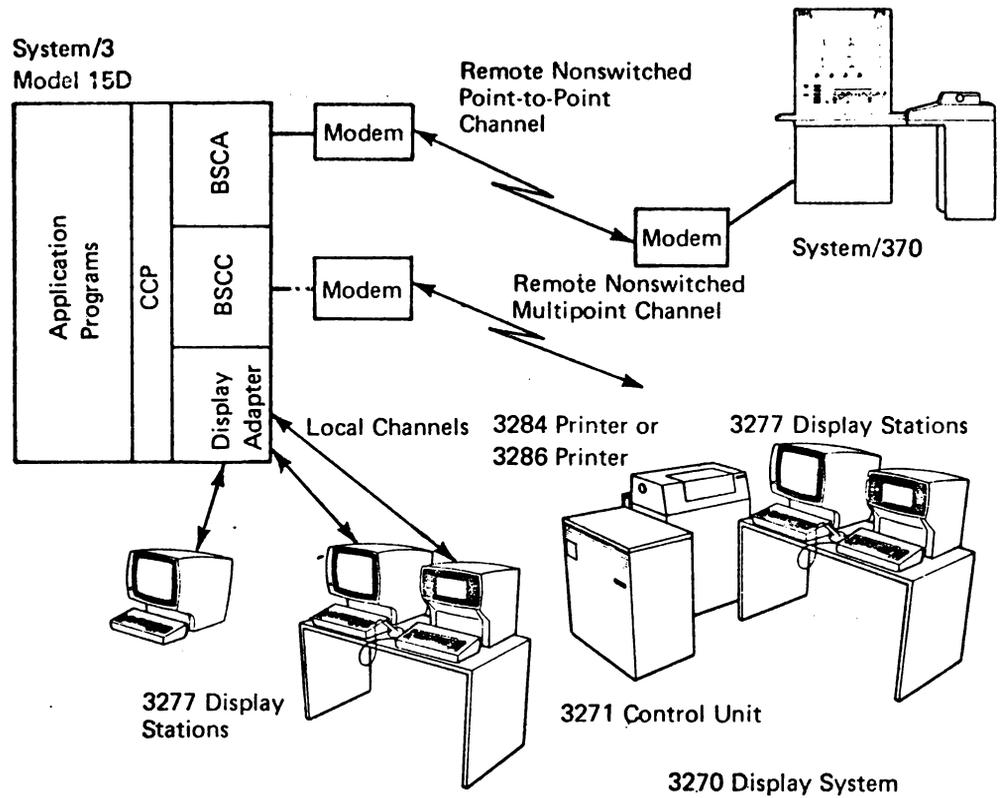
The following configuration shows the System/3 as a host system communicating with remote binary synchronous communication devices using the binary synchronous communications adapter (BSCA) and local 3270 devices using the display adapter (DA):



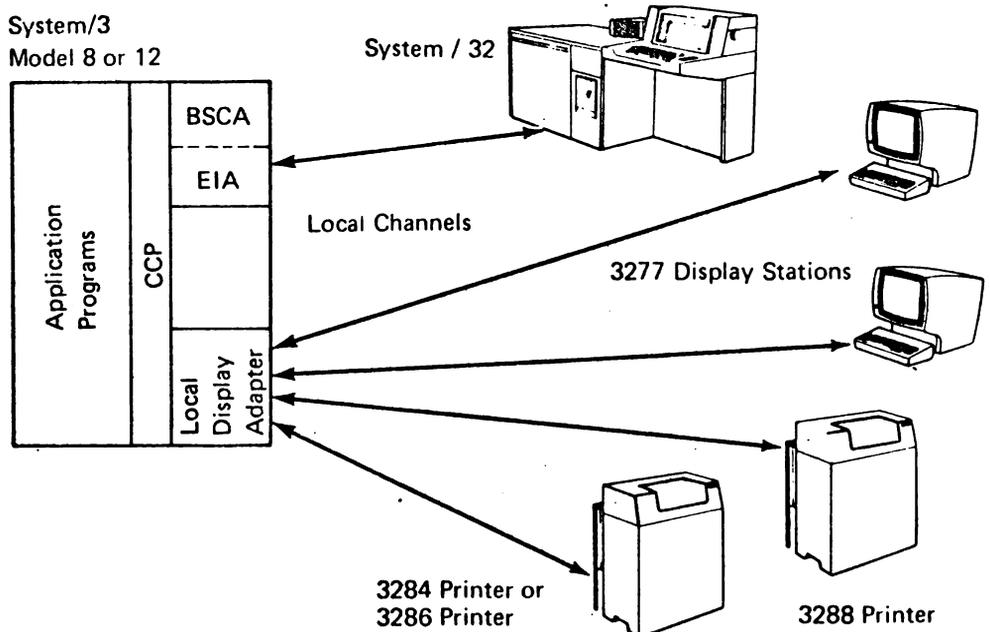
The System/3 in the following configuration is a subhost system to remote asynchronous terminals using the multiple line terminal adapter (MLTA), a subhost to local 3270 devices using the display adapter (DA), and communicates with a remote 370 host system using the binary synchronous communications adapter (BSCA):



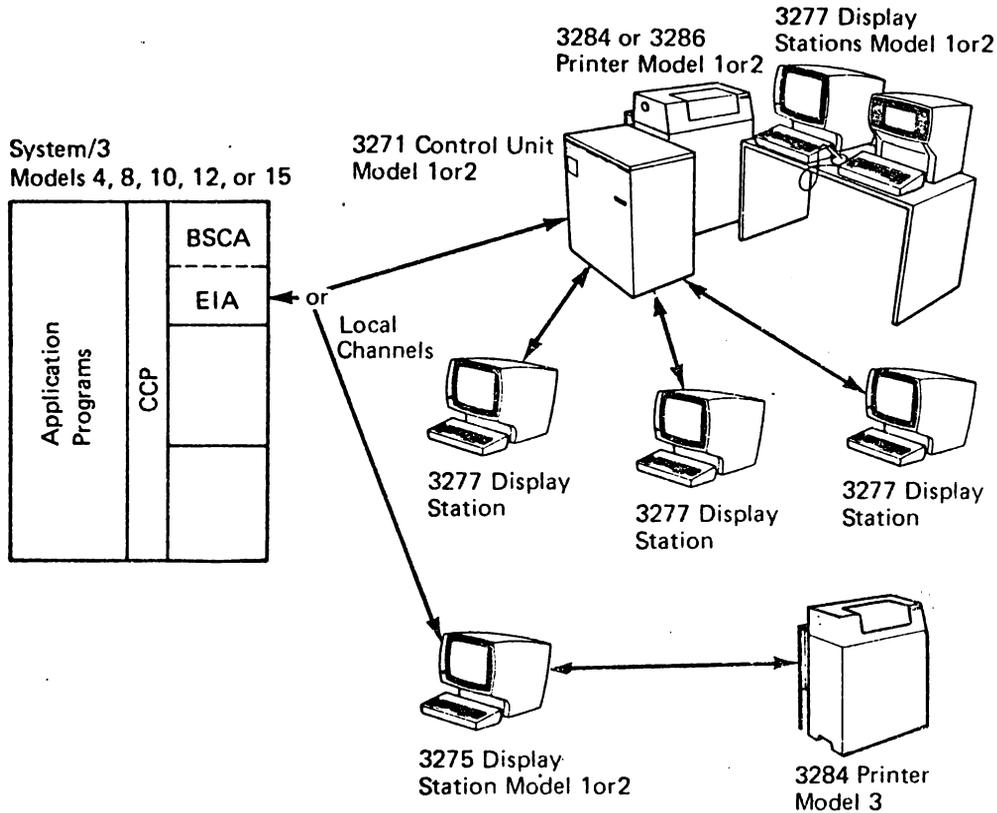
The System/3 in this configuration is a host system to remote synchronous terminals using the binary synchronous communications controller (BSCC), a subhost to local 3270 devices using the display adapter (DA), and communicates with a remote 370 host system using the binary synchronous communications adapter (BSCA):



This System/3 is a host system to local binary synchronous devices using the binary synchronous communications adapter (BSCA) with the EIA local attach feature and the local display adapter (local DA):



The System/3 in the following configuration is a host system to local 3270 devices using the binary synchronous communications adapter (BSCA) with the EIA local attach feature:



### MODEL 15D CHANNEL CONNECTED SYSTEMS

Channel-to-channel communications between two System/3 Model 15Ds is made possible by an RPQ that provides a modification of the SIOC (serial input/output channel), feature code 7081. (The maximum cable length between the two systems is 40 feet.) This RPQ is called *SIOC Connect S/3 to S/3* (number GJ0769). This RPQ is available for 5415 Processing Units (models D19 through D26), and it is required on each processing unit using this feature.

Some typical applications for two channel connected systems are:

- Sharing data files between systems.
- Providing additional growth for existing applications in such areas as file capacity, terminals, and performance.
- Distributing the work load between systems to provide better balance and improved systems availability. For example, one system can be used for CCP while the other is used for batch, or one system can be used for local terminals while the other is used for remote terminals.

The program support allows the user to operate in batch mode (a batch RPG II or assembler program in each system) or in CCP mode (CCP operating in each system). Program support for both environments is provided in program number 5799-WNK, and it consists of IOC (input/output supervisor), data management, and SUBR17 (interface subroutine).

Program support for batch operations consists of RPG II SPECIAL device extensions. The user simply reads from or writes to the other system in a manner similar to reading and punching cards.

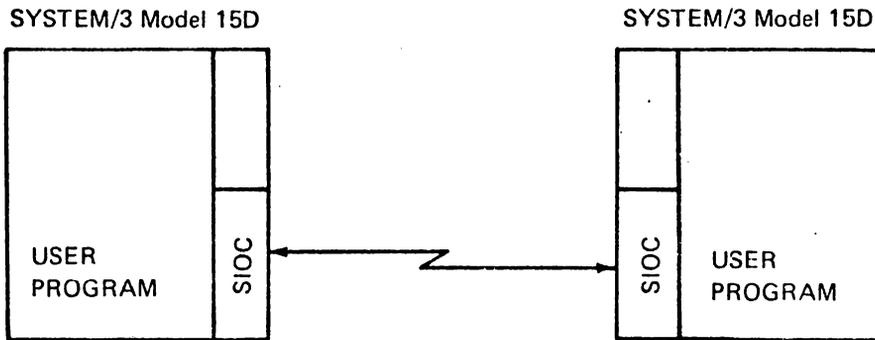
The CCP program support establishes each system as a command mode terminal to the other. This means that each system can load programs in the other system or pass transactions to already loaded programs in the other system. User programs (RPG II, COBOL, FORTRAN, and Assembler) communicate with the other in much the same way as they communicate with 3270 terminals.

The CCP assignment set options establish name IDs similar to terminal names for up to 49 logic ports representing the channel connection. A port is an access point for data entry and exit. A logical port is the logical connection for the user between the channel connected systems. For the single physical channel, there are multiple logical ports.

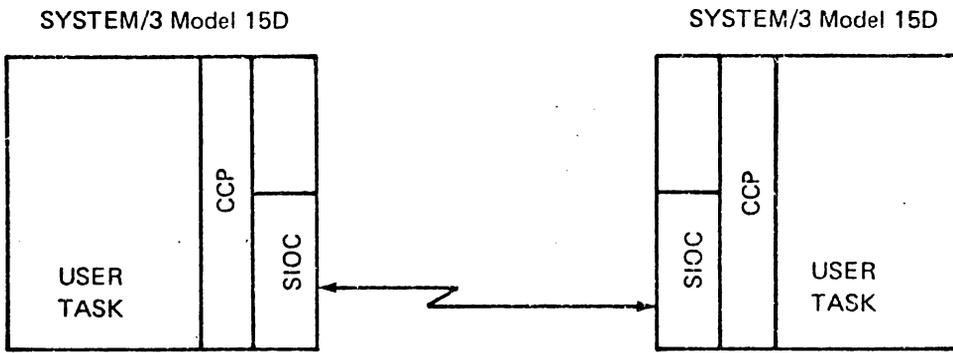
User programs acquire, read from, or write to a named logical port. For example, if a program load is required in the other system, a user program would acquire a port and write to that port using the normal 14-character CCP header. If using SUBR92, the header is followed by a data stream consisting of the name of the program to be loaded in the other system and the data to be passed. This operation is called a port command request.

Under CCP, multiple logical sessions may be established concurrently between tasks in each system; that is, several tasks in one system can be concurrently communicating with the tasks in the other system across the single channel.

In the following configuration, the System/3 Model 15Ds are communicating between batch programs using a modification of the SIOC (serial input/output channel).



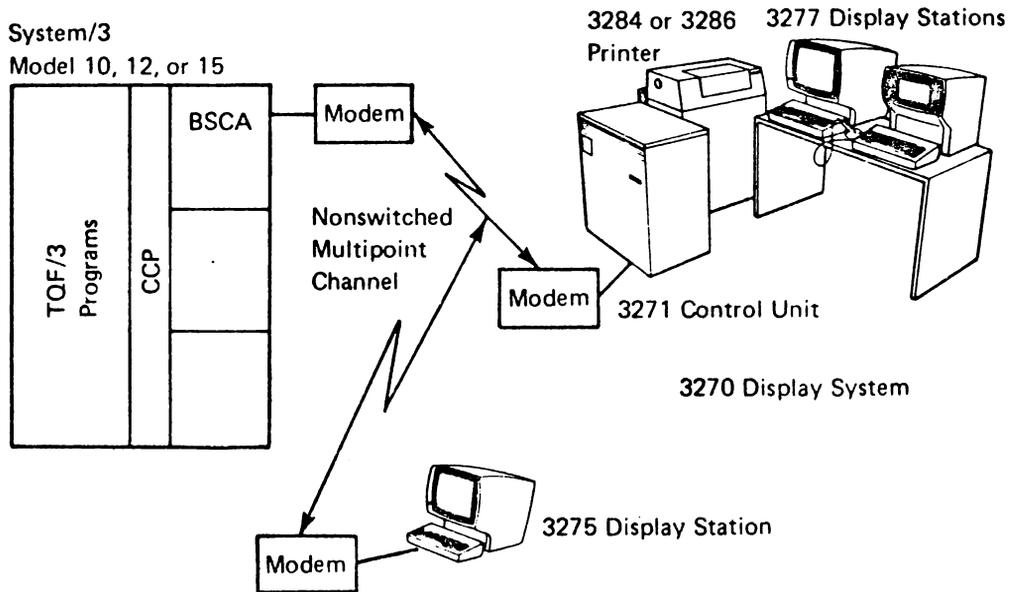
In the following configuration, two System/3 Model 15Ds are communicating between CCP tasks using a modification of the SIOC.



## TERMINAL QUERY FACILITY

The terminal query facility RPQ program product allows System/3 users to enter a complex inquiry directly into the System/3 via a 3277 or 3275 Display Station. The query is processed and the results are written on disk. The results may then be printed on the system printer and/or sent to the requesting terminal.

TQF/3 programs are written in RPG II and run under control of the communications control program. The following example shows a System/3 with TQF/3 programs, CCP, and BSCA, a remote 3275 Display Station, and remote 3270 Display System:



### BSCA Multiline Multipoint Feature

The MLMP (multiline/multipoint) programming support is used with the BSCA to allow a System/3 to communicate with binary synchronous terminals or other computers.

With the MLMP feature, programmers can write their own communication program(s) using macros and the basic assembler program product (or equivalent). The macro routines allow programmers to handle unique situations that may not be handled by one of the provided communication programs.

### Multiple Line Terminal Adapter Input/Output Control System

The MLTA (multiple line terminal adapter) programming support is used with the MLTA hardware adapter to allow a System/3 Model 10, 12, or 15 to communicate with a variety of asynchronous terminals.

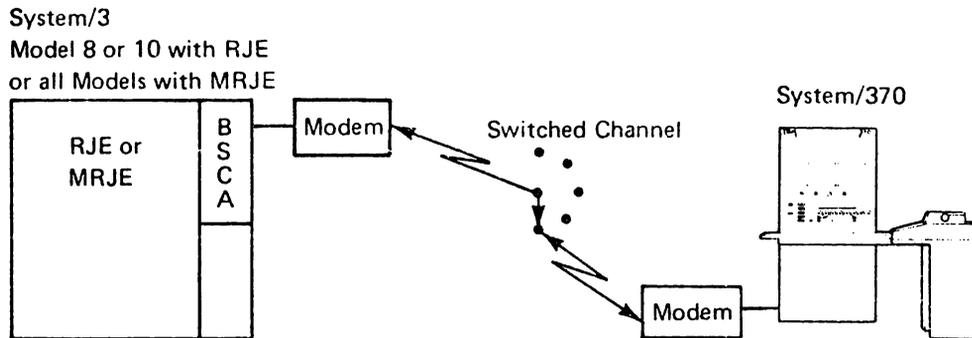
With the MLTA feature, programmers can write their own communication program(s) using macros and the basic assembler program product (or equivalent). The macro routines allow programmers to handle unique situations that may not be handled by one of the provided communication programs.

## Remote Job Entry Work Station Feature

The System/3 remote job entry (RJE) work station feature allows a System/3 user to submit OS/360 (IBM System/360 Operating System) jobs via binary synchronous communications to an OS/360 central computer. Output from the OS/360 jobs can be returned to the System/3 that submitted the jobs, sent to another work station, or sent to the OS/360 I/O devices.

## MULTI-LEAVING Remote Job Entry/Work Station Feature

The MULTI-LEAVING Remote Job Entry/Work Station (MRJE/WS) program allows a System/3 user to submit OS jobs from a System/3 via binary synchronous communications. Output from the OS jobs can be returned to the System/3, sent to another work station, or sent to the central computer I/O devices. MRJE can communicate with many of the central computer remote job entry subsystems. The MRJE/WS program allows concurrent input jobs, output jobs, and console requests. The following example shows an IBM System/3 with an RJE or MRJE program communicating with a System/370 via the binary synchronous communications adapter (BSCA) on a switched channel:



## **THE IBM SYSTEM/7**

With data communications, the System/7 can be used as a satellite processor or a master station (host). A System/7 can communicate with:

- An IBM 1800, a System/360, and a System/370 through the ACCA (asynchronous communications control attachment) feature.
- An IBM System/3, a System/7, and a System/370 through the BSCA (binary synchronous communications adapter) feature.

The IBM programming support for teleprocessing systems takes the form of access methods under OS/360 and DOS, which operate on the System/360 and System/370. DOS/VS, OS/VS1, and OS/VS2, operate on the System/370, System/3 and System/7 macros.

The System/7 asynchronous macros enable the System/7 to simulate the 2740 Communications Terminal Model 1 with its record-checking feature and its addressing feature (depending upon the communication method selected and the hardware configuration needed). The record-checking feature accommodates several System/7s and 2740 terminals of the same type on one line.

The System/7 binary synchronous communications macros enable a System/7 to communicate with a System/370 using DOS/VS, OS/VS1, or OS/VS2.

The System/7 binary synchronous communications macros enable a System/7 to communicate with a System/3 using the multi-point/multiline feature of the System/3 BSCA support or the System/3 communications control program.

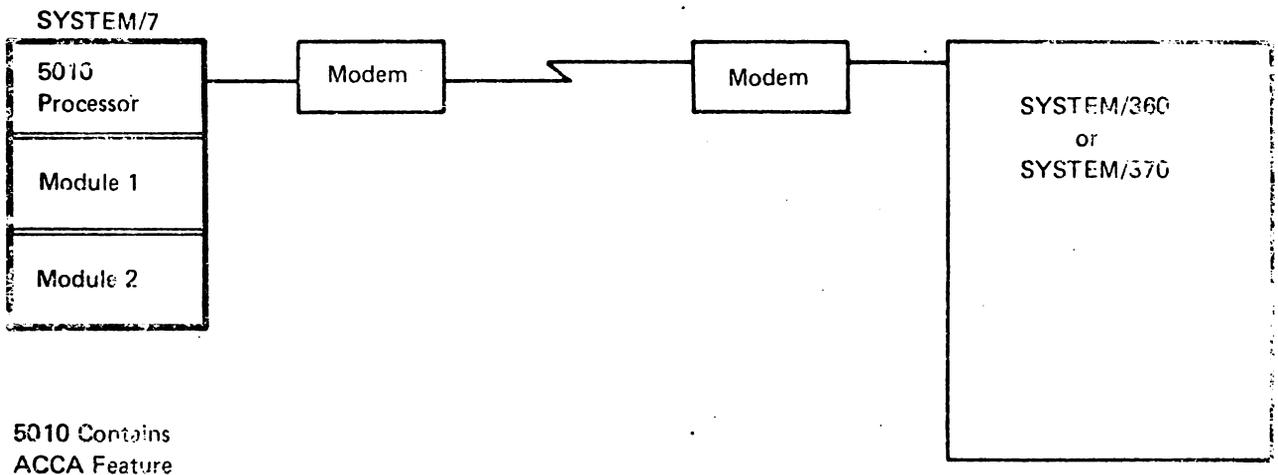
The BSC macros provided allow two System/7s to communicate in a point-to-point configuration.

Program products are available for System/7 under the license agreement for IBM program products.

## Customer Information Control System (CICS)

The CICS (customer information control system) program product operates under OS/360 and DOS and links the System/7 to a System/360 or System/370 with the ACCA. The System/7 operates as a terminal under CICS for transmitting data to the host computer and requesting execution of host programs centrally by CICS. These programs can be written in PL/1, COBOL, or Assembler language. CICS also supports access and transmission of System/7 programs from the host disk to a System/7.

The following configuration shows a System/7 linked to a System/360 or System/370 with ACCA.



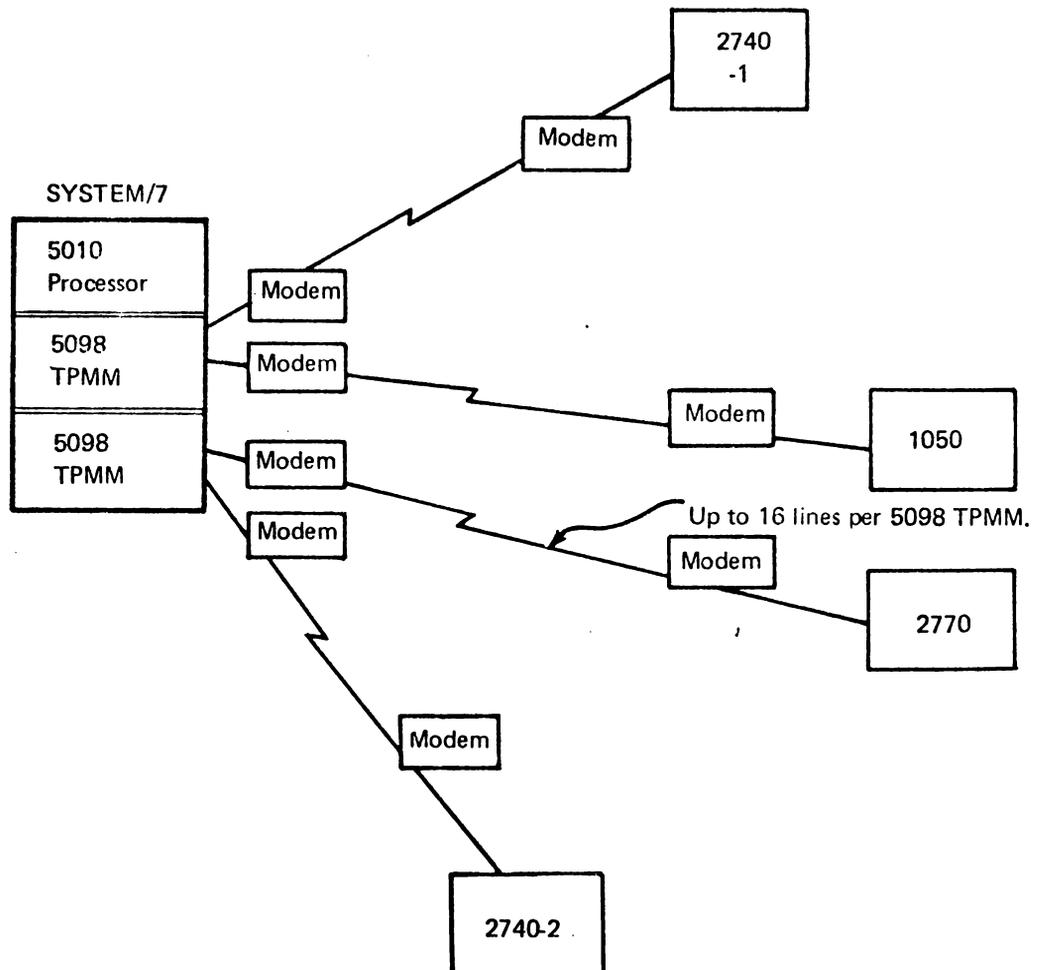
## Communication Control Application Program/7 (CCAP/7)

CCAP/7 (communication control application program/7) is a disk-oriented, stand-alone, and a completely operational teleprocessing package for the System/7 that controls a variety of start/stop terminals as well as binary synchronous terminals. CCAP/7 is designed to satisfy a wide range of message-switching requirements, by using the TPMM (teleprocessing multiplexer module) and disk storage. CCAP/7 performs network control and message processing functions.

CCAP/7 will handle as many as 64 communication lines and 100 terminals. The specific maximum network configuration may be determined only by very careful analysis of the speeds and terminal types. The supported terminals are:

- IBM 2740 Model 1
- IBM 2740 Model 2
- IBM 1050 Data Communication System
- IBM 2770 Data Communication System

The code structure used by the CCAP/7 is the ASCII transmission code. Transmission to a host system is also supported using the binary synchronous communication ASCII communications facility on a point-to-point basis. See the following configuration:



Some major features of CCAP/7 are:

- Flexible network and terminal support is provided. Manual message processing activities such as code conversion, routing, and data and time stamping are automatically performed. Head analysis and checking is automatically provided.
- The ability of the CCAP/7 to store messages destined for inoperable terminals eliminates a potential source of lost traffic.
- Message retransmission procedures assist the terminal and system operators in handling unforeseen events by providing an effective method for creating another copy of a message. The CCAP/7 system performs error-checking to help ensure accurate processing of messages.
- CCAP/7 is designed to provide a base to build on for those applications where the program can be added to or changed to fit the requirements of the user. Modularity of the system also allows system growth as the network requirements grow.
- When system generation is complete, the CCAP/7 program will be on disk and can be loaded into System/7 storage. Installation of an unmodified CCAP/7 program requires minimum effort.

CCAP/7 can provide functions similar to TCAM and QTAM, but on a smaller scale. Applications include:

- Message switching
- Message data collection
- Message concentration for host (CPUs).

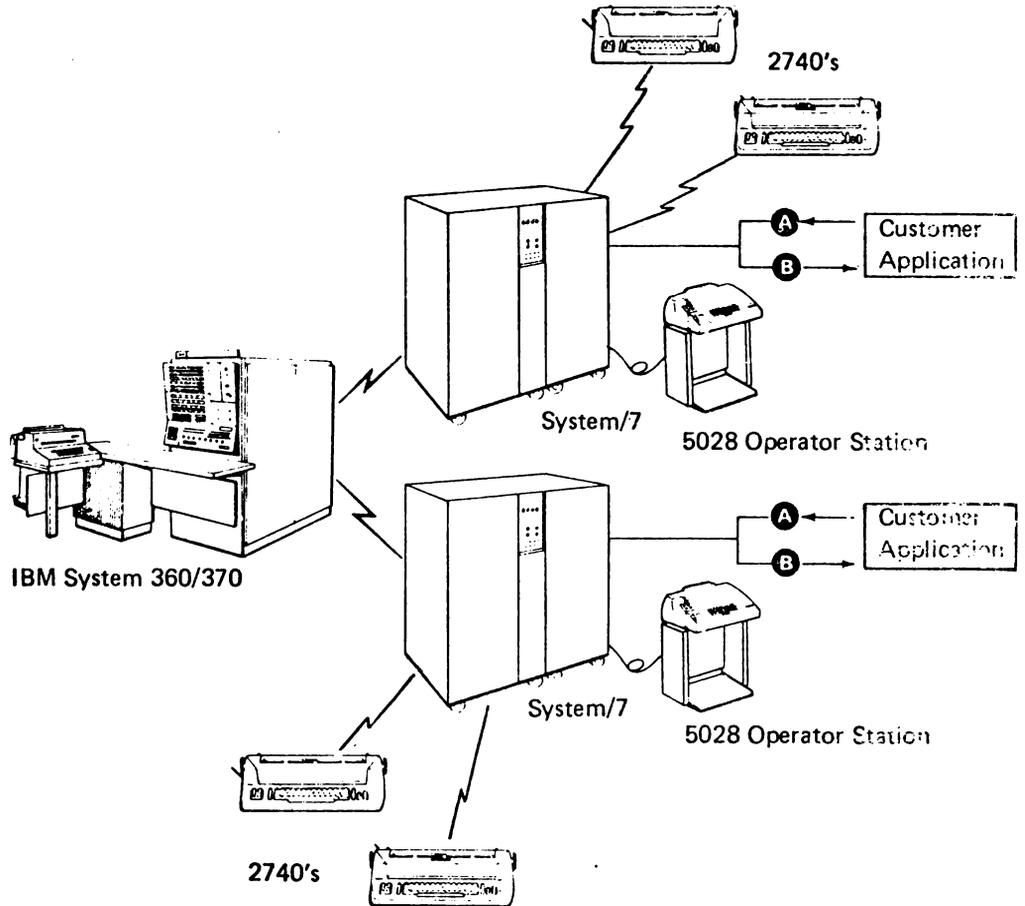
There are several ways CCAP/7 can improve communications methods and efficiency. They are:

- Automate manual procedures
- Replace inadequate systems
- Reduce line costs
- Front-end to one or more CPUs
- Provide an economical back-up system
- Improve world-wide communications

In summary, the CCAP/7 program product is intended to provide an easy-to-install, reliable and efficient general-purpose message-switching system. Error detection and recovery, flexible network and terminal support, comprehensive message services, and simplified installation procedures are an integral part of the CCAP/7.

## Remote Data Concentrator Program

The remote data concentrator programming RPQ for the IBM System/7 concentrates messages from start/stop terminals, data from user-written 2790 applications, and sensor based applications through a System/7 to a host System/370 or System/360. The following illustration shows a typical configuration.



The Remote Data Concentrator Program resides in the System/7. The program continually polls remote terminals, receives and translates messages from these terminals, assembles messages into blocks and then transmits complete message blocks to the host. The System/7 functions as both a line and data concentrator.

The System/7 interfaces with the host by simulating the IBM 3271 (control unit for the 3270 Information Display System). The user is able to take advantage of the broad base of programming support available on the System/370 and System/360 for the IBM 3270. The data is transmitted from the System/7 in complete message units to the host computer. Only one BSC termination port is required to interface the remote System/7 with the host computer.

The CPU monitors only one data stream from the System/7. The data stream is transmitted at high speed and contains complete message units.

The remote data concentrator handles error checking for the terminals. This means that if an error occurs, the program can ask for a retransmission. After several retries, the system may decide to disable a line or a terminal. Also, the System/7 has a BSCM (binary synchronous communication module) that handles the data link to the host. The BSCM link provides two advantages:

- Transmission is at a faster transfer rate.
- Transmission is accomplished on a reliable and checked communication facility.

In summary, some features of the remote data concentrator program are:

- It handles the interface with remote terminals. It performs the polling, addressing, and error checking. The modular design of the program makes it possible to add many terminal types. It relieves the host CPU of the burden of line control for the individual terminals.
- It handles the code translation. Data is presented to the host in a standard format.
- The program sends complete message to the host. The host does not have to assemble the message parts.
- Highly reliable BSCM is used for the data link to the host.
- 3270 simulation provides a standard terminal interface that takes advantage of extensive programming support.
- Both the host and the System/7 use standard software support. All the hardware features, standard and RPQ, are supported on the System/7 by Host Program Preparation Facilities II.

## **THE IBM SYSTEM/32**

With data communications, the System/32 can be used as a host system, a processor terminal, and/or an RJE or MRJE/Work Station. The following communication programs are provided for the System/32 to allow it to communicate with terminals, other systems, or both:

- Binary synchronous communications (BSC) (a standard feature of System/32 RPG II)
- Remote job entry (RJE) RPQ
- MULTI-LEAVING Remote Job Entry/Work Station (MRJE/WS) program
- Batch work station (BWS) utility program

### **Binary Synchronous Communications**

With the binary synchronous communications feature, a System/32 user can send data to or receive data from terminals or other systems using binary synchronous communications. A special RPG II coding sheet is available to code the communications portion of the program (binary synchronous communications is also supported by basic assembler language macros) to permit the System/32 to:

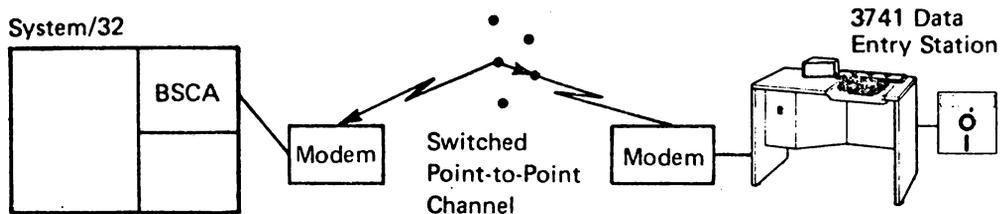
- Receive only
- Transmit only
- Alternately transmit and receive

The following BSCA features, options, and capabilities are supported by the binary synchronous communications feature:

- Manual call and manual answer
- Automatic answering
- Station selection
- EBCDIC or ASCII code structure and EBCDIC transparency

The System/32 can communicate via point-to-point switched channels, point-to-point nonswitched channels, or via a multipoint channel as a tributary station.

In the following configuration, the System/32 is a host system to a 3741 Data Station via switched channels using the binary synchronous communications feature:



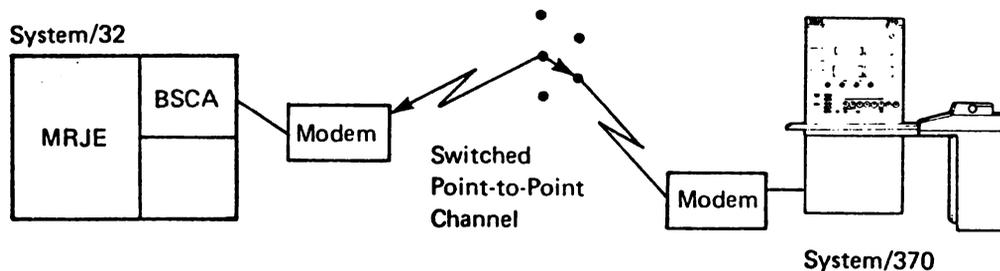
### Remote Job Entry PRPQ

The System/32 remote job entry (RJE) programming RPO allows a System/32 user to submit OS or DOS jobs from a System/32 via binary synchronous communications to a central OS/360 or OS/370 with HASP or to a DOS/360 or DOS/370 with POWER. Output data is returned to the System/32 printer, disk, or both.

### MULTI-LEAVING Remote Job Entry Work Station Program

The MULTI-LEAVING Remote Job Entry Work Station (MRJE/WS) program allows a System/32 user to submit jobs from a System/32 via binary synchronous communications to a central System/370. Output from these jobs can be returned to the System/32, to another work station, or sent to the central computer I/O devices. A System/32 with MRJE/WS can communicate with many of the central computer remote job entry subsystems. The MRJE/WS program allows the System/32 user to submit input jobs, execute output jobs, or enter console requests concurrently.

In the following configuration, the System/32 is an RJE or MRJE work station using a switched channel, the binary synchronous communications adapter, and the RJE or MRJE program:



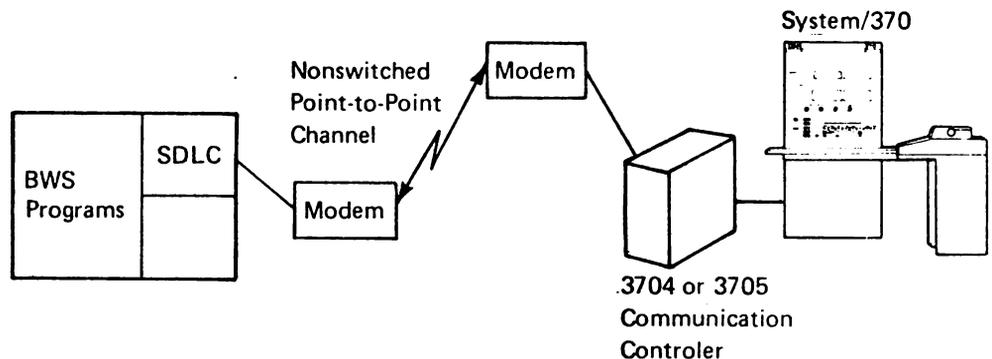
## Batch Work Station Utility Programs

The batch work station (BWS) utility programs allow a System/32 user to communicate with System/370 programs using the SDLC adapter on the System/32.

The batch work station utility for RJE (BWSUR) allows a System/32 user to submit OS and DOS jobs from a System/32. The output from these jobs can be returned to the System/32, sent to another work station, or sent to the central computer I/O devices.

The batch work station utility for DB/DC (BWSUD) allows a System/32 user to transmit data to or receive data from System/370 CICS and IMS Programs.

In the following configuration, the System/32 is a batch work station. The System/32 can communicate with a central System/370 via a switched or nonswitched point-to-point channel or a multipoint channel using the SDLC adapter and one of the BWSU programs:



## THE IBM SYSTEM/34

With data communications, the System/34 can be a host system, a subhost system, a processor terminal, and/or an RJE work station. The System/34 and its program products provide the following data communications capabilities:

- Binary synchronous communications (BSC) support in RPG II and basic assembler language.
- MULTI-LEAVING remote job entry utility
- System network architecture (SNA) support in basic assembler language.
- SNA remote job entry utility
- Remote work station support

## **Binary Synchronous Communications**

System/34 supports RPG II and basic assembler language programs using BSC (binary synchronous communications). The support performs all functions necessary to establish line connections, exchange identification sequences, send and receive data, and execute correct termination procedures.

The BSC support permits System/34 to function as any of the following station types:

- Receive only (receive data from a remote station).
- Transmit only (transmit data to a remote station).
- Transmit and receive (no conversational reply). The following modes of operation are possible:
  - Transmit a file, then receive a file
  - Receive a file, then transmit a file
  - Transmit records of one file interspersed with receiving records of another file

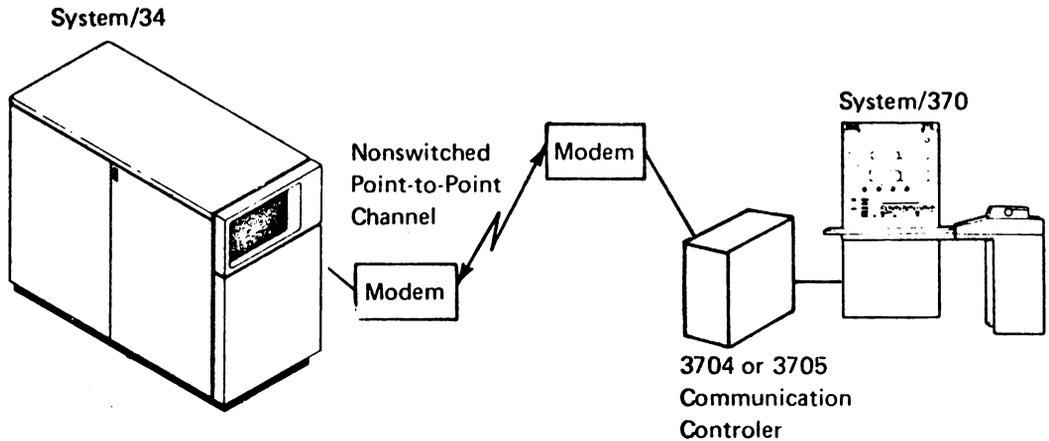
## **MULTI-LEAVING Remote Job Entry Utility**

The MULTI-LEAVING remote job entry (MRJE) utility allows a System/34 to submit jobs to a System/370 using BSC (binary synchronous communications). Output from these jobs can be returned to the System/34, to another work station, or to the host system I/O devices. A System/34 with MRJE can communicate with many of the System/370 remote job entry subsystems. System/34 MRJE can run in automatic mode (without System/34 operator intervention), and can also accept input from up to three System/34 display stations (three as readers) and one as a console (which must be the System/34 system console).

## **SNA Remote Job Entry Utility**

The SNA remote job entry (SRJE) utility allows a System/34 to submit jobs to a System/370 using SDLC (synchronous data link control) and SNA (systems network architecture). Output from these jobs can be returned to the System/34, to another work station, or to the host system I/O devices. SNA can maintain eight concurrent sessions on one line. SRJE uses only one of the sessions leaving the other seven available for user applications. System/34 SRJE can communicate with the RES, JES2, and POWER/VS subsystems at the host System/370.

In the following configuration, one System/34 is attached to a host 370 via nonswitched point-to-point channel.



### System Network Architecture

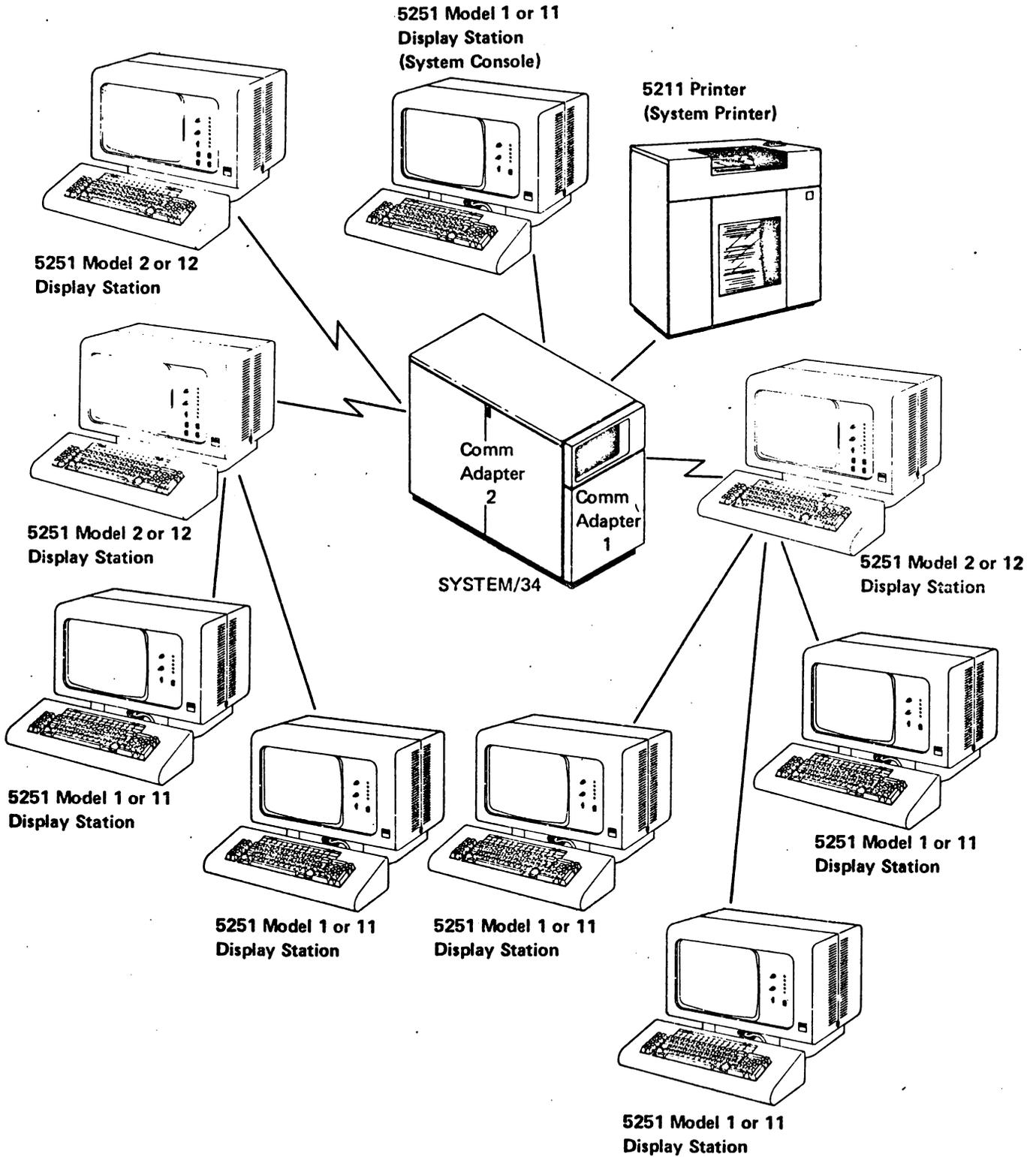
System/34 provides programming support for SNA (systems network architecture) communications from System/34 to System/370 CICS and IMS through basic assembler language macroinstructions. System/34 SNA operates on a communications line using synchronous data link control.

Multiple programs can operate concurrently within one System/34. The System/34 can maintain a maximum of eight concurrent SNA sessions on one line.

### Remote Work Station Support

System/34 supports the attachment of remote 5250 work stations using systems network architecture and synchronous data link control. The functions performed at the remote display stations and printers are identical to those performed on locally attached work stations with no user application programming changes required. The System/34 can handle up to 64 work station devices attached remotely on one or two communications lines. The System/34 can also run remote work station support and other communications support concurrently, thereby allowing the System/34 to function as a subhost system.

The following configuration shows a System/34 with eight remote display stations. Three of the remote display stations (Models 2 or 12) attach to the communications line; the other five display stations (Models 1 or 11) attach to the Model 2 or 12 display stations.



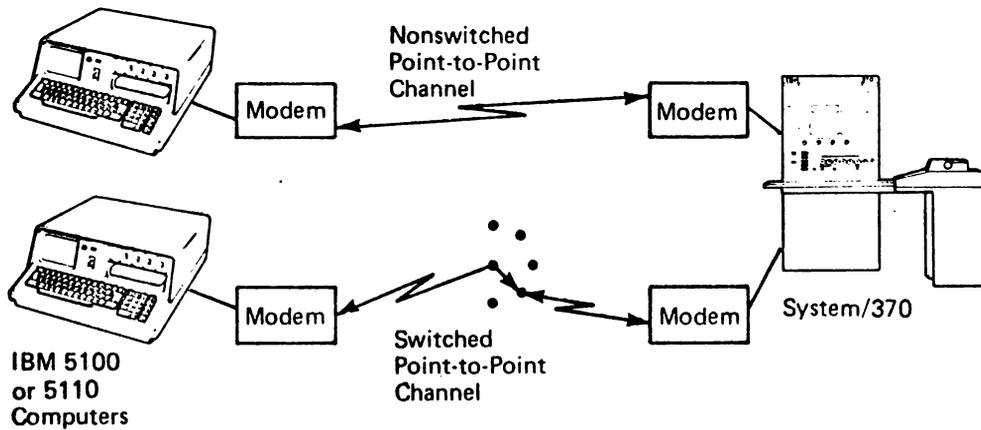
## THE IBM 5100 AND 5110 COMPUTER

The IBM 5100 and 5110 computers use asynchronous and binary synchronous communications.

### The 5100 and 5110 Computer with Asynchronous Communications

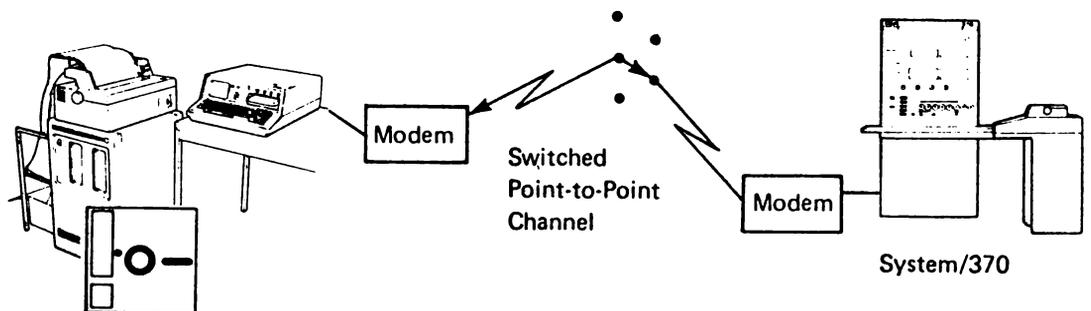
The 5100 and 5110 function as terminals with the communications adapter feature or the ASCII communications RPQ (see Chapter 6, *Terminals*).

In the following configuration, one 5100 or 5110 is attached to a host System/370 via a point-to-point switched channel and another is attached via a point-to-point nonswitched channel using the expansion feature and the communications adapter feature or ASCII communications RPQ:



### The 5110 with Binary Synchronous Communications

In the following configuration, a 5110 with a printer and diskette unit is attached to a System/370 via a switched point-to-point channel.



## THE IBM 5230 DATA COLLECTION SYSTEM

The 5230 Data Collection System can transmit data to the host system in one of three modes of operation:

- Batch mode – the transmission of data currently on diskette to the host system
- Online mode – the transmission of data directly from the entry stations to the host system
- Interleaved mode – the transmission of data currently on diskette and the interleaving of online data as it is entered from the entry stations to the host system

The 5230 Data Collection System uses binary synchronous communications over switched or nonswitched point-to-point or multipoint (nonswitched) lines to communicate with:

- IBM System/370 Models operating under DDS/VS, OS/VS1, or OS/VS2 BTAM. The BSCA attachment is supported by CICS/VS operating under DDS/VS and OS/VS.
- IBM System/32 with BSCA (point-to-point only)
- IBM System/34 with BSCA (point-to-point only)
- IBM System/3 Models 4, 6, 8, 10 (Disk), 12, or 15 with BSCA, LCA, ICA, or EIA
- IBM System/7 with TPMM or TPMF RPQs
- IBM 3741 restricted to single diskette transfer (point-to-point only)

### Data Collection System Support

The DCSS program provides such functions as editing and reformatting on data collected from the plant floor. These functions are performed before the data is submitted to the application program, such as payroll, inventory management and production status. The DCSS is available for operation on a System/32, System/34, and System/3.

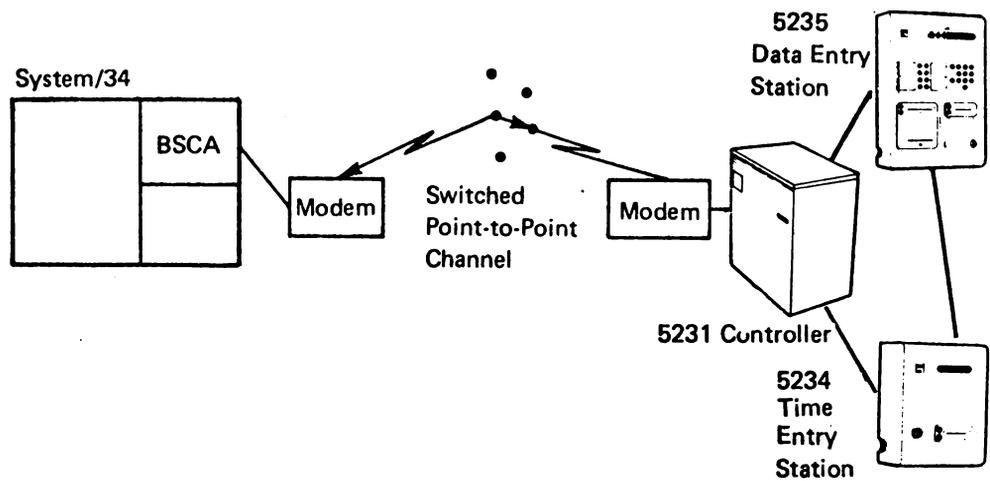
## On-line Data Collection and Inquiry

Other programs allow the 5230 System transactions to be transferred to the System/32 or System/34 computer upon receipt of the data at the 5231-2 Controller. The programs provide the following functions:

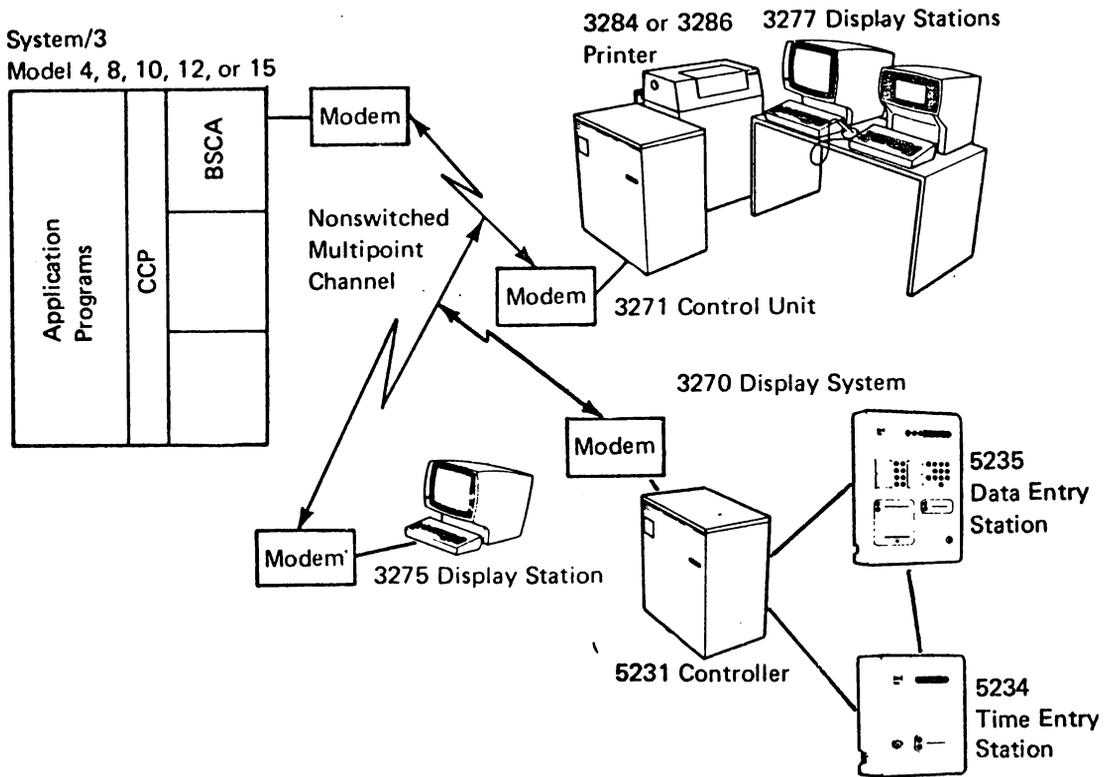
- Online transaction sequence control
- Online transaction editing and error reporting
- System/32 control center transaction error resolution or error resolution using IBM 5251 CRTs connected to System/34
- Production data base control
- Inquiry directly through the System/32 console or through 5251 CRTs connected to System/34
- Spooling of edited, approved transactions from a disk file to a remote host system via a common carrier facility

The following are sample configurations showing the attachment of the 5230 Data Collection System.

With the following configuration, the user can collect data from the plant floor, transmit the data to a System/34 via a switched point-to-point channel, and process the data in the host system for subsequent query by devices attached locally to the host system.



The following configuration shows the System/3 as a host to a remote 5230 Data Collection Systems using the BSCA. The communications network contains a nonswitched multipoint channel and the attachment to the channel for the 5230 system is via a 5231 Model 2 Controller.





## Appendix A. Glossary

This glossary contains a list of some of the common terms that you may read or hear when working with data communications. The terms are described only as they relate to data communications.

**acknowledge:** To respond to a poll, address, or message.

**acknowledgment:** The characters or data that a receiving station sends in response to a poll, address, or message. For example, an acknowledgment from a terminal to a poll or address indicates the status of the terminal.

**addressing:** Selecting the station on a multipoint channel to which data will be transmitted.

**alternate routing:** Using an alternate path to transmit data when the usual path is not available.

**amplifier:** A device that amplifies signals to allow data transmission over long distances.

**amplitude modulation:** A method of modifying the amplitude of a carrier signal so it can carry data.

**analog signals:** Continuously variable data signals, such as voice signals or a sine wave.

**answering station:** The station responding to a dialed call on a switched channel.

**application program:** A user provided program that performs the user's jobs.

**ASCII (American standard code for information interchange):** A standard 8-bit code (usually 7 data bits and 1 parity bit) used to represent data.

**asynchronous transmission:** Data transmission in which each data character is individually synchronized on a communication channel, usually by using a start bit and a stop bit. Also called start-stop transmission.

**attended operation:** In data communications, some equipment requires a person at each station to establish the data channel. For example, one person dials a location, waits for the other person to answer, then both persons push a button to switch from voice to data communications.

**attenuation:** A decrease in signal strength of a data signal on a communication channel.

**automatic calling unit (ACU):** A device that allows a host to automatically dial the number of a remote device.

**bandwidth:** The difference, in Hertz, between the two limiting frequencies of a band.

**batch processing:** Processing data after it is accumulated and similar items are grouped together.

**baud:** Baud is the number of changes in signal levels, frequency, or phase per second on a communication channel. If each change represents one bit of data, baud is the same as bits per second. However, it is possible for one signal change (one baud) to equal more than one bit of data.

**Baudot code:** A 5-bit transmission code structure that is used to represent data.

**bel:** Ten decibels.

**bid:** An attempt to gain control of the channel to transmit data.

**binary synchronous transmission:** Synchronous transmission of binary coded data.

**bit:** The smallest unit of data in a binary computer. Represented by a 1 (one) or a 0 (zero).

**bit rate:** The speed at which serialized data is transmitted, usually expressed in bits per second.

**buffer:** A device or area in computer storage that is used to store data to compensate for a difference in data flow rate from one device to another.

**carrier signal:** A signal with a constant frequency that can be modulated to carry a data signal.

**central office:** Location of common carrier switching equipment that routes data. They are also called exchange offices.

**channel:** The electrical path between data communications equipment.

**character:** A letter, number, or special symbol (such as an asterisk, comma, or percent sign) contained in data or used to control communication devices.

**communications common carrier:** A company that offers communication services to the public.

**conditioning:** Adding equipment to a communication channel to improve the data transmission qualities of the channel.

**contention:** A condition on a communication channel when two stations attempt to use the same channel simultaneously.

**control character:** A character that is transmitted to control a function of the device that receives the character. For example, indicates the end or beginning of data to a station.

**control station:** Station controlling a multipoint channel that addresses and polls all other stations.

**cross talk:** Undesired signals, such as voice signals, transferred to a data channel.

**data access arrangement:** Data communication equipment that permits attachment, of privately owned data terminal equipment, and data communications equipment to the network.

**data set:** See *modem*.

**dataphone**<sup>1</sup>: A telephone device designed for data communications.

**decibel:** A unit of signal strength, such as a signal on a data communications channel.

**demodulation:** Removing the data signal from the carrier signal. Opposite of modulation.

**digital data:** Data represented by on and off conditions called bits.

**disconnect signal:** A signal transmitted to a receiving station to indicate that the channel is to be disconnected.

**distortion:** An undesirable change in a data communications signal.

**duplex:** Data transmission in both directions simultaneously.

**EBCD (extended binary coded decimal):** A 7-bit code (6 data bits and one parity bit) used to represent data.

**EBCDIC (extended binary coded decimal interchange code):** An 8-bit code (eight data bits) used to represent data.

**echo:** A reflected signal on a communication channel.

**exchange:** See *central office*.

**FD or FDX:** Full duplex. See *duplex*.

**figure shift:** Shifting a typewriter from letters to numbers and special characters. The term is used with the Baudot code.

**filter:** An electronic component or group of components that is designed to allow only specified signal frequencies to pass through the filter.

**four wire circuit:** A circuit that uses four wires (two for transmitting data and two for receiving data) for data transmission. Four wire is used at times for duplex transmission; however, duplex transmission in some systems does not use four wire circuits.

**frequency modulation:** Modifying the frequency of a carrier signal so it can carry data signals.

**full duplex:** See *duplex*.

**half duplex:** Data transmission in both directions on the channel but not simultaneously.

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<sup>1</sup>Trademark of the Bell System

**handshaking:** Before transmitting data, modems and equipment must establish an electrical path and synchronization. The process used to establish the path and synchronization is called handshaking.

**HD or HDX:** See *half duplex*.

**host:** The controlling or highest level system in a data communications configuration.

**inplant systems:** A data communications system in which all components of the system are located in the same building or on adjacent locations.

**intelligent terminal:** A terminal that can perform some of the functions of a computer.

**interface:** The interconnection between two distinct devices having different functions.

**leased facility:** See *nonswitched channel*.

**letters shift:** Used with the Baudot code to indicate shifting a typewriter to print letters (lowercase characters).

**mark:** Indicates the presence of a data signal on a communication channel.

**mark hold:** Condition of the channel when no data is being transmitted; the channel is held at a steady mark level.

**microwave:** A high frequency radio wave (above 890 megahertz) used to transmit data.

**modem:** A device that modulates an analog carrier signal with digital data signals and transmits the composite signal. A modem also receives the composite signal and demodulates it to recover the digital data.

**modulation:** Altering a carrier signal to carry data signals on a communication channel.

**multidrop:** Stations connected to a multipoint channel at one location are called multidrop stations.

**multipoint channel:** A data communications channel with two or more stations on the same channel.

**network:** In data communications, a number of communication channels interconnecting a host with terminals and/or other hosts.

**noise:** Undesirable electrical signals on the communication channel that can interfere or distort data signals.

**off hook:** Indicates the data connection is active. For example, if you remove the telephone from the hook or cradle, it is active.

**offline:** A station that has not established a communication link with another station.

**on hook:** Indicates the data connection is not active. For example, if you hang up the telephone (on hook), it is not being used.

**online:** A station that has established a communication link with another station.

**online system:** A system in which input data enters the host directly from the point of origin and/or output data is transmitted directly to where it is used.

**parallel transmission:** Transmitting all bits of a character simultaneously.

**parity check:** Checking a data character for an odd or even number of 1 bits.

**phase modulation:** Altering the phase of a carrier signal to convey data signals.

**point-to-point:** A channel connected between only two stations. A point-to-point channel can be switched or nonswitched.

**poll list:** A list of terminal addresses in computer storage; the addresses are used to poll the terminals.

**polling:** An ordered procedure of inviting stations on a multipoint channel to transmit data.

**primary station:** On a point-to-point channel, the station that gains control of the channel first, on a multipoint channel, the station controlling communications.

**processing batch:** Accumulating and grouping related data for processing.

**processor terminal:** A programmable terminal or computer that can process data offline and can also be used as a terminal online.

**pulse modulation:** Transmitting data by altering (modulating) a pulsed or intermittent carrier.

**real-time system:** A system that receives and processes data so the data or result is available for immediate use.

**response time:** The time it takes for a data communications system to respond to a request. For example, if you enter a customer number on a terminal keyboard, response time begins when you press the last key and ends when the first character of your answer is displayed at the terminal.

**secondary station:** The station that receives control from a primary station.

**selection:** See *addressing*.

**serial transmission:** Transmitting each bit of a data character separately over the same electrical path.

**simplex channel:** A channel that can transmit data in only one direction.

**space:** Indicates the absence of a data signal on a communication channel.

**start-stop:** See *asynchronous transmission*.

**station:** An input or output point of a communication system.

**subhost:** A communication system that controls attached terminals in addition to communicating with another (usually higher level) system.

**subvoice:** Indicates a channel with a lower bandwidth than a voice grade channel.

**synchronous transmission:** Sending all bits of a character and all characters of a transmission at a constant rate.

**tariff:** The established rates for data communications services.

**telecommunications:** Transmitting signals over long distances.

**teleprocessing:** Processing data that is received from or transmitted to a remote location via communication channels.

**terminal:** Any device that can send and/or receive data via a communication channel.

**tributary station:** A station on a multipoint channel receiving control from a control station.

**voice grade channel:** A channel that can transmit voice signals. They are also used for data communications.

**wide band channel:** A communication channel that has a greater bandwidth than a voice channel; therefore, it is capable of transmitting data at high speeds.

## Appendix B. Bibliography

This bibliography contains a list of publications containing more detailed information on the subjects and/or products that are discussed in this manual. You can order these publications from your IBM representative or your local IBM branch office.

### BATCH WORK STATION

The *IBM System/32 Data Communications Reference Manual*, GC21-7691 describes System/32 SNA/SDLC communication concepts; batch work station system utility program input, output, commands, and program operation; and System/32 statements required to operate the system utility program for RJE and DB/DC.

### BINARY SYNCHRONOUS COMMUNICATIONS

The *IBM Systems Reference Library—General Information—Binary Synchronous Communications*, GA27-3004 contains information on binary synchronous communication concepts, transmission codes, data link operation, message formats, additional data link capabilities, and planning considerations.

The *System/7, 5098-N03 Binary Synchronous Communications Module: General Information Manual (RPQ D08080)*, GA34-1501 describes a family of custom products which provide the System/7 with Binary Synchronous Communications Capabilities. It covers configuration, unique PIO commands, data field, specific operations, and other related information. Ordering information for the 5098-N03 (BSCM) can be found in the description and Price Transmittal for RPQ D08080.

The *IBM Series/1 Binary Synchronous Communication Control Program Support PRPQ 82516 User's Guide*, SC34-1553 contains information on the function provided by the IBM Series/1 Binary Synchronous Communication Control Program Support. It provides the procedures required for the user to install and use the support provided. In addition it contains detailed information on the following:

- Hardware supported
- Programming considerations
- Interface modules
- Error messages and codes
- Trace facility

## **CHANNEL CONNECTED SYSTEMS**

The *IBM System/3 Model 15D Channel Connected Systems Program Reference and Logic Manual*, GC21-5199 contains information on channel-connected Model 15Ds that use the modified SIOC (serial input/output channel).

## **COMMUNICATIONS CONTROL PROGRAM**

The *IBM System/3 Communications Control Program General Information Manual*, GC21-7578 provides a general description of the Communications Control Program.

The *IBM System/3 Communication Control Program System Design Guide*, GC21-5165 is a guide to designing a System/3 that uses the communications control program. This manual includes information on:

- Application design concepts
- The use of direct files
- File sharing
- 3270 screen design
- The use of printers under CCP
- System security and integrity
- Queuing theory
- Performance tips

The *IBM System/3 Communications Control Program Terminal Operator's Guide*, GC21-7580 contains both introductory and reference information necessary to use the System/3 Communications Control Program from a terminal. It also includes consideration for terminals supported by CCP and a description of the commands used by terminal operators to request CCP services related to loading and executing application programs.

The *IBM System/3 Models 8, 10, and 12 Communications Control Program System Reference Manual*, GC21-7588 and the *IBM System/3 Model 15 Communications Control Program System Reference Manual*, GC21-7620 describe the communications control program feature of the IBM System/3 Models 8, 10, 12, and 15. These manuals also provide information to aid programmers in generating the CCP system and include information on:

- Using the CCP from a terminal
- System operator control of the CCP
- CCP services for the applications programmer
- Designing your communications system
- CCP generation and assignment

The *IBM System/3 Models 8, 10, and 12 Communications Control Program Systems Operator's Guide*, GC21-7581 contains information about using the IBM System/3 Model 10 Disk System Communications Control Program (CCP) for System/3 Models 8, 10, and 12. It also includes information on:

- The role of the system operator
- Generation and assignment
- Startup and shutdown
- Controlling the CCP after startup
- Entering terminal operator commands and program requests from the console
- Operational storage message formats
- CCP halts
- The disk file recovery program
- The glossary
- The sample printout of commands

**The IBM System/3 Model 15 Communications Control Program System Operator's Guide, GC21-7619 contains information about using the IBM System/3 Communications Control Program (CCP). It also includes information on:**

- **The role of the system operator**
- **Startup and shutdown**
- **Controlling the CCP after startup**
- **Entering terminal operator commands and program requests from the console**
- **Operational stage message formats**
- **The disk file recovery program**
- **The glossary**
- **Sample commands**
- **The main storage dump to printer program**
- **Online tests**
- **Program errors**

**The IBM System/3 Model 4 Operator's Guide, GC21-5149 gives information needed to operate the devices and programs for the System/3 Model 4. It also includes an introduction to operating the Model 4 and information on device operation, system operations, and messages/halts and how to recover.**

**The IBM System/3 Model 4 Communications Control Program Concepts and System Design Guide, GC21-5148 describes communications control program concepts and system design requirements for the System/3 Model 4. The publication includes:**

- **A summary description of Model 4**
- **A survey of the facilities of the communications control program feature of Model 4 system control programming**
- **A description of the factors to consider in designing a Model 4 system for use in an online work station environment**
- **Application program design examples**

The *IBM System/3 Model 4 Communications Control Program Programmer's Reference Manual*, GC21-5150 describes how to write communication application programs to run under control of the communications control program.

The introduction summarizes the requirements of an application program interface to CCP. Subsequent chapters describe the RPG II routines and CCP operations, the use of the 3270 Display format facility, the CCP assignment stage, and the preparation of source programs to run under CCP and application program testing.

The *IBM System/3 Model 4 Introduction*, GC21-5146 introduces the System/3 Model 4 to those who will program, operate, or manage the system. The manual contains information on concepts and facilities, the communications control program, programming support, related publications, and pregenerated CCP options.

The *IBM System/3 Communications Control Program Messages Manual*, GC21-5170 helps identify the IBM System/3 CCP messages and tells how to respond to them. This manual contains all the operational messages, termination codes, terminal messages, and halts associated with System/3 CCP operations for all System/3 models.

### **DATA/3**

The *IBM System/3 DATA/3 Reference Manual*, SC21-5102 describes how to use DATA/3 to write programs for inquiry, updating, and data entry. The overview describes the four types of programs that can be generated by DATA/3 and a summary of how to generate, compile, and execute the programs. Subsequent chapters describe in detail how to fill out and use the two forms for each type of program; how to generate, compile, and execute programs; and what diagnostic messages can be received. Programming examples are included for reference.

### **MULTILINE/MULTIPOINT**

The *IBM System/3 Multiline/Multipoint Binary Synchronous Reference Manual*, GC21-7573 provides information required to use the multiline/multipoint, (MLMP) feature with the System/3. The manual describes MLMP functions, MLMP macro instructions, diagnostics, and diagnostic aids. The manual also includes system requirements and considerations.

### **MULTILINE TERMINAL ADAPTER**

The *IBM System/3 Multiple Line Terminal Adapter RPQ Program Reference and Component Description Manual*, GC21-7560 contains information concerning MLTA features, describes the instruction set and the procedures to use the MLTA features, and the appendixes contain control block formats, tables, installation procedures, and other information pertinent to the MLTA and program analysis.

## **RPG II TELECOMMUNICATIONS FEATURE**

The *IBM System/3 RPG II Telecommunications Programming Reference Manual*, SC21-7507 contains information needed to write an RPG II communications program. It also includes a description of each of the specifications required and sample programs that illustrate programming techniques and possible applications for System/3 RPG II communications programming.

The *IBM System/32 Data Communications Reference Manual*, GC21-7691 provides information needed to write System/32 RPG II communications programs. It contains a definition of basic communication terms, a description of the communication capabilities of the System/32, and the RPG II telecommunications specifications that are required to write a communication program for the System/32. It also includes sample programs, programming techniques, and possible applications for System/32 RPG II telecommunications programming.

The *IBM System/34 Data Communications Reference Manual*, SG21-7703 contains information that describes the capabilities of data communications support for RPG II. The specifications required to write an RPG II data communications program for System/34 and sample programs are included to illustrate programming techniques and possible applications.

## **RPG II 3270 DISPLAY CONTROL FEATURE**

The *IBM RPG II 3270 Display Control Feature Reference and Logic Manual*, SC21-5161 describes how to write telecommunications application programs to run under control of the RPG II 3270 display control feature and provides information to aid the RPG II application programmer and IBM systems engineer.

The introduction to the manual summarizes the requirements of the display control feature. Subsequent chapters describe the application program interface, the operations and their codes, how to write RPG II application programs, and internal logic of the display control feature. The appendixes provide explanations of the return codes, messages and halts, and summaries of the 3270 identification and control codes.

## **REMOTE JOB ENTRY AND MULTI-LEAVING REMOTE JOB ENTRY**

The *IBM Series/1 Remote Job Entry PRPQ P82575 User's Guide*, SC34-1589 describes the functional capabilities and installation procedures for the IBM Series/1 Remote Job Entry support. It contains information on the devices supported, the command procedures used to communicate with RJE and information on the host support. In addition this publication includes the following:

- Messages and codes
- Operator procedures
- Execution time options

The *IBM System/3 Remote Job Entry Work Station Support Reference Manual*, GC21-7531 provides reference information for programmers using the System/3 remote job entry work station support. In addition, an operator guide, halt list, and RJE polling characters list are included in the appendixes.

The *IBM System/3 MULTI-LEAVING Remote Job Entry Work Station Support Reference Manual*, GC21-7621 provides information for programmers and operators using the IBM System/3 MULTI-LEAVING remote job entry work station (MRJE/WS) program with System/3 Models 4, 6, 8, 10, and 12. It includes information on work station input and output, MRJE/WS command, operation control language (OCL), MRJE/WS program operation, and program generation. The appendixes include an MRJE/WS command summary, MRJE/WS messages, BSCA trace table, and MRJE/WS print utility.

The *IBM System/3 Model 15 MULTI-LEAVING Remote Job Entry/Work Station Support Reference Manual*, GC21-5115 contains information on work station input/output, MRJE/WS commands, operation control language (OCL), MRJE/WS program operation and generation, and MRJE/WS print utility. The appendixes include MRJE/WS messages, MRJE/WS halt messages, MRJE/WS trace facility, and primary storage estimates.

The *IBM System/32 Data Communications Reference Manual*, GC21-7691 contains information on work station input and output, MRJE/WS commands, MRJE/WS program operations, and the DCSUP print utility for MRJE/WS output. The appendixes include MRJE/WS line protocols, altering the BSC environment, data link control summary, and EBCDIC and ASCII code charts.

The *IBM System/32 Remote Job Entry PRPQ Information Manual*, GC21-7653 provides reference information for operators and programmers using the System/32 remote job entry program with HASP and POWER/VS. It also includes operating instructions, installation instructions, and program listings.

The *IBM System/34 Data Communications Reference Manual*, SG21-7703 contains information that describes the MULTI-LEAVING Remote Job Entry utility for RJE (remote job entry) host systems. The procedure command that can be used to load and run the utility, the functions of the utility, and the utility control statements required to control the operation of MRJE are provided.

## **TERMINAL QUERY FACILITY**

The *IBM System/3 Terminal Query Facility Program Description/Operations Manual*, SC21-5107 describes the terminal query facility (TQF/3), the individual programs comprising the TQF/3, and input/output requirements. It also provides all instructions to make the installation operational.

## **TERMINALS**

The *IBM Communicating Magnetic Card Selectric Typewriter Reference Manual*, G543-0608 describes the functional characteristics of the Communicating Magnetic Card Selectric Typewriter.

The *IBM 1050 Data Communications System Principles of Operation—System Reference Library Manual*, GA24-3474 provides a complete description of the operating principles of the 1050. The functional characteristics of the system and each component is described in detail. Additional information pertaining to the overall system is provided in the appendix.

**The IBM 2740 Communications Terminals Model 1 and 2 Component Description—Systems Reference Library Manual, GA21-3403** describes the application areas, principles of operation, line control signals, and special features of the 2740 Models 1 and 2. The communication facilities and modems that can be used with the 2740 are also described. It includes the timing formulas that are necessary to calculate the data handling capability of the 2740.

**The IBM 2741 Communication Terminal—System Reference Library Manual, GA24-3415** describes uses, principles of operation, data link control, and special features of the IBM 2741 Communication Terminal. The communications facilities that can be used with the 2741 are discussed. Also included are programming considerations, code charts, and keyboard arrangements.

**The Introduction to the IBM 3270 Information Display System Manual, GA27-2739** contains planning information about the 3270 that includes local and remote display stations and printers. The publication:

- Describes the 3270 hardware (units, features, functional capabilities) and its programming support
- Outlines applications for alphanumeric displays and guidelines for conversion
- Gives data on human factors, installation planning, reliability, and performance

**The IBM 2770 System Summary—System Reference Library Manual, GA27-3014** describes the basic and special features, applications, and capabilities of the 2770. The manual also discusses the organization of the system, the control unit and its relationship with input and output devices, and the programmed manual, and automatic operation of the system.

**The IBM 2780 Data Transmission Terminal—Component Description, GA27-3005** describes the principles of operation of the 2780. The data link control characters, code structures, timeouts, and throughput rates associated with binary synchronous communications are described. Also described are communication facilities, modems, and special features for the 2780.

**The IBM Systems Reference Library—Component Descriptions: IBM 2972 Models 8 and 11 General Banking Terminal Systems Manual, GL27-3020** describes the features and the operating principles of the 2972. Each unit is described and its functions are discussed in detail. Also included is information on manual indicators, keyboard configurations, passbook specifications, communication sequences, and available RPQ's.

**The IBM System/3 Model 10 Disk System 3735 Application Package Manual Programming RPQ, GC21-5096** contains coding information for the 3735 application package.

**The IBM 3741 Data Station Reference Manual, GA21-9183** describes the basic and special features, application, and capabilities of the 3741.

The *IBM 3747 Data Converter Reference Manual and Operator's Guide*, GA21-9170 explains how to use the 3747. The manual contains information on programming considerations, disk and tape operations, the binary synchronous communication feature, operating considerations, and error recovery.

The *IBM 5100 Computer Communications Adapter Feature User's Manual*, SA21-9215 describes how to operate the feature, lists the error codes applicable to the 5100 communications feature, and how to use the communications adapter self test to check the 5100 communications feature. The appendixes included are setup instructions, sample programs, and translation code charts.

The *IBM 5110 Binary Synchronous Communications Feature User's Manual*, SA21-9316 describes how to use the 5110 with binary synchronous feature. The manual also contains information needed to plan, set up, and check out the feature.

The *IBM 5110 Asynchronous Communications Feature User's Manual*, SA21-9314 describes how to operate the feature, lists the error codes applicable to the 5110 communications feature, and describes how to use the communications adapter self test to check the 5110 communications feature. The appendixes include setup instructions, sample programs, and translation code charts.

The *IBM 3767 Models 1, 2, and 3 Communication Terminal Component Description Manual*, GA27-3096 describes the 3767 Communication Terminal. It gives an overview of the 3767, describes the applications and features of the 3767, and describes the communication facilities required. This manual also includes operating controls, keyboard layouts and code charts, and terminal identification and address.

*Component Information for the IBM 3780 Data Communication Terminal*, GA27-3063 introduces the IBM 3780 Communication Terminal. The terminal's applications, capabilities, and design highlights are discussed. It also discusses the use of binary synchronous communications, a description of associated data link control characters, code structures, timeouts, communications facilities, IBM modems, and special features for the 3780.

## **SYSTEMS NETWORK ARCHITECTURE**

The *IBM Systems Network Architecture General Information Manual*, GA27-3102 describes the basic terminology, concepts, and scope of systems network architecture (SNA).

## **SYNCHRONOUS DATA LINK CONTROL**

The *IBM Synchronous Data Link Control General Information Manual*, GA27-3093 contains a brief background and basic description of the terminology and concepts of SDLC. It also includes a catalog of SDLC components and some representative examples of their uses.



- ACCA 56
- acknowledgment negative 12, 22
- acknowledgment positive 12
- ACK0 32
- ACK1 32
- adapters 43
  - Series/1 44
  - System/3 51
  - System/7 55
  - System/32 59
  - System/34 60
- address 14
- address field, SDLC 35
- addressing 14
  - how a host addresses 16
- air miles 19
- alternating positive acknowledgments 32
- analog signals 26
- application program 8
- ASCII 21
- asynchronous 27, 28
- asynchronous communications single-line control 44
- asynchronous communications eight-line control 45
- asynchronous communications four-line control 45
- asynchronous communications on 5100 & 5110 77
- asynchronous communications control attachment 56
- asynchronous data link control characters 29
  
- batch mode 119
- batch work station utility, System/32 114
- baud 21
- BCC 21, 22, 31
- BCC erase 21
- bid for the channel 12
- binary synchronous communications 27, 31
- binary synchronous communications adapter 46, 60
- binary synchronous communications
  - single-line control 46, 47
- binary synchronous communications four-line control 48
- binary synchronous communications controller 52
- binary synchronous data link control characters 32
- bisync 27
- bits 21
- bits lost or gained 22
- bits per second 21
- block check characters 22
- block lengths 23
  
- block message 23
- block size 23
- blocks 23
- BSC 27, 48
- BSCA, System/3 51
- BSCA, System/7 55
- BSCA, System/32 59
- BSCA, System/34 60
- BSCC 52
- buffering, double 25
- buffers 24
- business machine clocking 27
- BWS 114
- BWSUD 114
- BWSUR 114
  
- CCAP/7 108
- CCP 94
- channel 9
- channel conditioning 21
- channel miles 19
- characters, control 27
- charges, network 19
- check character 22
- check data validity 22
- check field, SDLC 35
- check sequence 22
- checking 22
- CICS 107
- circle B 29
- circle C 29
- circle D 29
- circle N 29
- circle S 29
- circle Y 29
- clock 27
- clocking, business machine 27
- clocking modem 27
- cluster feature 81
- code structures 21
- commands, examples of using 38
- commands, list of 37
- commands, SDLC 37
- common carrier 9, 11
- common terms 123
- Communicating Magnetic Card Selectric 64

**communications adapter** 8, 43  
**communications control application program** 108  
**communications adapter feature, 5100** 77  
**communications channel** 8  
**communications common carrier** 9, 11  
**communications facility** 9  
**communications indicator panel** 49  
**communications lines** 9  
**communications link** 10  
**communications network** 9, 10  
**communications program, System/7** 51  
**communications program, System/32** 59  
**communications program, 5100** 77  
**communications program, 5110** 77  
**communications programs** 8  
**communications programs, Series/1** 44  
**communications programs, System/3** 51  
**components of a data communications system** 8  
**conditioned switched channels** 11  
**conditioning, channel** 21  
**contention** 13  
**control character sequence, asynchronous** 27  
**control characters** 27, 29  
**control field, format** 36  
**control field, SDLC** 35  
**control station** 14  
**controlling the communications link** 38  
**CRC** 22  
**customer information control system** 107  
**customer owned and maintained channels** 10  
**cyclic redundancy checking** 22

**data collection system support** 119  
**data communications** 1  
**data communications benefits** 1  
**data communications configuration** 2  
**data communications definition** 1  
**data communications system** 1  
**data communications system components** 7  
**data communications system, definition** 1  
**data communications uses** 1  
   **data entry** 1  
   **inquiry** 1  
   **record updating** 1  
   **remote batch entry** 1, 5  
   **remote job entry** 1

**data entry** 1  
**data files** 1  
**data link control** 27  
**data link escape** 32  
**data pump** 26  
**data set** 26  
**data terminal equipment** 43  
**data validity** 22  
**DCE** 43  
**DCSS** 119  
**DDSA** 78  
**dial circuits** 10  
**dial lines** 10  
**digital signals** 26  
**disk** 5  
**display adapter** 54  
**double buffering** 25  
**DTE** 43  
**dual cluster feature** 81  
**duplex** 20  
**duplex channel** 20  
**duplex transmission** 20

**EBCD** 21  
**EBCDIC** 21  
**EIA** 43  
**eight-line communications control, asynchronous** 45  
**eight-line communications control, binary synchronous** 47  
**Electronics Industry Association** 43  
**end of address** 29  
**end of block** 29  
**end of text** 32  
**end of text block** 32  
**end of transmission** 32  
**ENQ** 32  
**enquiry** 32  
**EOA** 29  
**EOB** 29  
**EOT** 29  
**ETX** 31  
**external clocking** 27

Federal Communications Commission 19  
flag, SDLC 35  
four-line adapter 45  
frame format 37  
frame, SDLC 35  
frame sequence example 40  
full duplex 20

glossary 123  
GSD products with communications 83

half duplex channel 20  
host system 2

I/O buffer 24  
ICA 53  
improving transmission efficiency 23  
information field, SDLC 35  
inquiry 1  
integrated communications adapter 53  
integrated display adapter 55  
integrated modems 26  
intelligent terminal 2  
interchange record separator 32  
interleaved mode 119  
intermediate text block 32  
internal clock communications features 81  
internal clocking 27  
interstate rates 19  
intrastate rates 19

layers 42  
  application 42  
  function management 42  
  transmission subsystem 42  
LCA 54  
leased lines 10  
line adapters 26  
line buffer 25

line turnaround time 21  
line turnaround time, affect on transmission 21  
local channel 9  
local communications adapter 54  
local display adapter 54  
longitudinal redundancy checking 22  
LRC 22

mark hold 28  
MLTA 53  
modem 19, 26  
modem clocking 27  
MRJE/WS, System/32 59, 113  
MRJE/WS, System/34 115  
multiline multipoint 104  
multiple line terminal adapter 53, 104  
multipoint channel 11  
MULTI-LEAVING remote job entry 105

NAK 32  
negative acknowledgment 32  
network 9  
nonintelligent terminal 2  
nonswitched channel 10  
Nr count, SDLC 36  
Ns count, SDLC 36

online mode 119

PAD 31  
point-to-point channel 12  
poll/final bit, SDLC 36  
polling 14, 16  
polling, how a control station polls 16  
primary station 13  
print buffer 24  
processor, terminal 63  
Public Utility Commission 19

rates 19  
 real-time 3  
 real-time programming system 84  
 record update 3  
 remote batch entry 1, 5  
 remote channel 9  
 remote communications 43  
 remote data concentrator program 110  
 remote job entry 1, 6  
 reverse interrupt 32  
 RJE/WS 59  
 RPG II telecommunications feature 91  
 RPG II telecommunications feature, System/3 91  
 RS-232 43  
 RVI 32

SDLC 27, 35, 60  
 secondary station 13  
 selection 14  
 serially 21  
 Series/1 adapter 44  
 signal distortion 24  
 signals, analog 26  
 signals, digital 26  
 signals, voice 26  
 single-line control communications 44  
 single-line control communications, asynchronous 44  
 single-line control communications, binary synchronous 46  
 SNA 42  
 SOA 29  
 SP bit 28  
 ST bit 28  
 start of header 32  
 start of text 32  
 start-stop 27  
 STX 31  
 subhost system 2  
 switched channels 10  
 SYN 31  
 synchronization 27  
 synchronization, SDLC 35  
 synchronous 27  
 synchronous data link single-line control 48  
 synchronous data link control adapter 60  
 synchronous data link control 27, 35  
 System/3 adapter 51  
 System/7 adapter 55  
 System/32 adapter 59  
 System/34 adapter 60  
 systems network architecture 42

tape 5  
 tariffs 19  
 teleprocessing multiplexer module 58  
 temporary text delay 32

timeouts 18  
 timing transmission 27  
 TPMM 58  
 transmission speed 21  
 transmission, duplex 20  
 transmission, half duplex 20  
 tributary station 14  
 TTD 32  
 turnaround time 21

validity check 22  
 vertical redundancy checking 22  
 voice signals 26  
 VRC 22

WACK 32  
 wait before transmitting 32

1050 data communications system 65  
 2740 communications terminal 66  
 2741 communications terminal 66  
 2770 data communications system 67  
 2780 data transmission terminal 68  
 2972 general banking terminal system 69  
 3270 information display system 70  
 3735 programmable buffered terminal 71  
 3741 data station 72  
 3741 programmable work station 72  
 3747 data converter 73  
 3767 data communications terminal 74  
 3770 data communications terminal 75  
 3773 communications terminal 75  
 3774 communications terminal 75  
 3775 communications terminal 75  
 3776 communications terminal 75  
 3777 communications terminal 75  
 3780 communications terminal 76  
 5100 computer 77  
 5110 computer 77  
 5230 data collection system adapter 62  
 5230 data collection system 79, 119  
 5231 controller (Model 2) 79  
 5234 time entry station 79  
 5235 data entry station 79  
 5250 information display system 80  
 5251 display stations 80