Burroughs Corporation

COMPUTER SYSTEMS GROUP
SANTA BARBARA PLANT

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B1800/B1700 DATA COMMUNICATIONS

PRODUCT SPECIFICATION

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BURROUGHS CORPORATION
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INTRODUCTION

Data Communications is designed to provide a general introduction to data communications (Datacomm) as it exists on B1800/B1700 systems. It defines both hardware and software components of Datacomm systems and provides a glossary of the basic terms used to describe Datacomm hardware and software. It assumes that the reader has a working knowledge of the basic structure of the B1800/B1700 processor and its peripherals.

RELATED DOCUMENTATION

NAME	NUMBER
B1800/B1700 Network Definition Language (NDL) Reference Manual	1073715
B1800/B1700 Software Operational Guide	1068731
B1800/B1700 Systems Reference Manual	1057155
B1800/B1700 Systems User Programming Language (UPL)	1067170
B1800/B1700 Systems Report Program Generator (RPG) Reference Manual	1057189
B1800/B1700 Systems COBOL Reference Manual	1057197
B1800/B1700 Data Communications Subsystems	P.S. 2205 7434
B1800/B1700 Network Definition Language	P.S. 2212 5223
B1800/B1700 Supervisory Message Control Systems	P.S. 2219 0482
B1800/B1700 Message Control System Interface	P.S. 2212 5447

DATA COMMUNICATIONS CONCEPTS

GENERAL

The term "data communications" (Datacomm) denotes the bidirectional transfer of data between a central computer and one or more terminals. Datacomm is the interfacing of remote users and devices (terminals) with on-site functions performed by the central computer. The B1800/B1700 Data Processing System can function as the central system for a network of remote devices (terminals) or as a satellite computer to a large system. Figure 2.1 illustrates a Datacomm network.

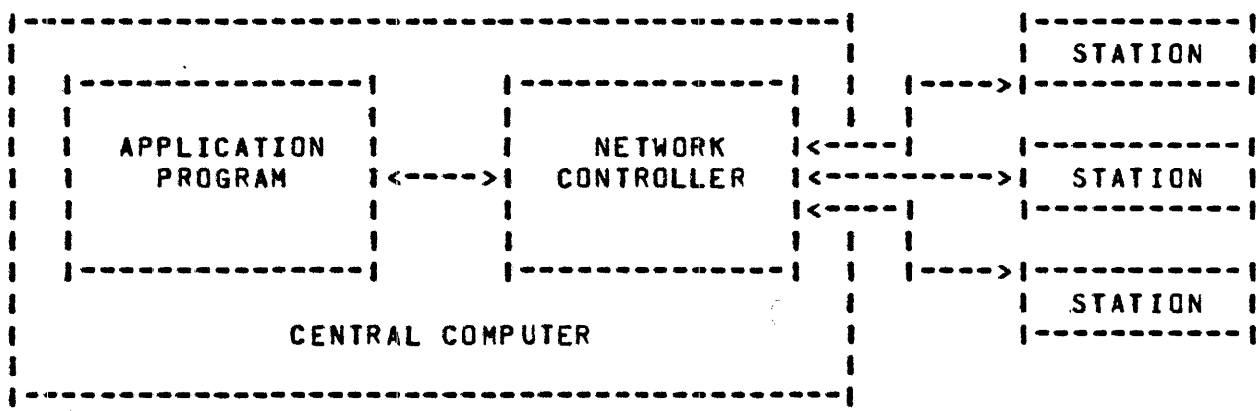

Figure 2.1 A Typical Data Communications Network

A Datacomm network includes a central computer and the remote devices which are attached to it (i.e., lines, adapters, terminals). Terminals will vary in how they communicate with the system. The specific type of terminal used can range from a "teletypewriter" unit to another computer. The distance between the terminal and the central computer, and the type of transmission lines used can also vary within the Datacomm network.

DATACOMM APPLICATIONS

The applications of the Datacomm system are numerous and varied in function. The hardware supporting the applications will also vary. The major applications are briefly described below.

a) Inquiry processing or on-line processing makes use of central locations. A prompt response can be provided for each inquiry. The data transmission is bidirectional and can be combined with real-time file updating, where a transaction causes the central data files to be immediately updated to show the current status of the appropriate accounts.

b) Data collection involves the collection of data by unidirectional data flow from remote terminals to a central processing point.

c) Data distribution uses unidirectional data flow in transmitting data generated at a central processing point to terminals. Data collection and data distribution are combined in many Datacomm systems.

d) Message switching is a method of handling large amounts of data to be dispersed among widely separated locations. The data flow is bidirectional between a central switching center and the terminals connected to it. The central switching center may perform processing of the data or any code conversion required.

e) Remote Job Entry allows users at different remote sites to use the central computer simultaneously. The data flow is bidirectional, with data and the instructions for processing transmitted from the remote terminals to the central computer. After the desired processing is performed, the results are transmitted back to the terminal. The main advantage of Remote Job Entry is that the user at a remote location has fast access to the computer.

FILE-HANDLING TECHNIQUES

Application programs communicate with stations or sets of stations (families) through file-handling techniques. Symbolic file names, together with the appropriate OPEN, CLOSE, READ, or WRITE commands are used for most communications with terminals.

Note that with the use of file-handling techniques, application programs usually do not have to be rewritten when system software or hardware configurations are changed; application programmers need not be data communications experts in order to utilize data communications networks.

DATACOMM SYSTEM INDEPENDENCE

The system design requires that the Master Control Program (MCP), which is the B1800/B1700 Operating System, be as independent of the Datacomm system as possible. This independence allows the operating system to be smaller in size than it would be otherwise, without penalizing the non-Datacomm system user. The functions of the Datacomm system and the B1800/B1700 Operating System are separate and distinct, and maintaining them as separate entities is advantageous to both.

B1800/B1700 SYSTEM DATA COMMUNICATIONS HARDWARE

The B1800/B1700 Data Communications System is a combination of special hardware and software that performs data communications. The special Datacomm hardware consists of terminals, transmission lines, data sets, adapters, and I/O controls. A description of each is included in this section. Control codes and I/O descriptors, although not hardware, are also described in this section because of their relationship to the special hardware of the Datacomm system.

TERMINALS

Terminals are the electronic or electromechanical devices that can be attached to the transmission lines of a Datacomm system, providing a man/machine interface between the user of the network and the network itself.

When information is sent from a terminal to the central system, the terminal transmits the bit representation of the character through the transmission line. A B1800/B1700 Data Processing System can serve as a terminal itself. It may be connected to a Datacomm system that has another computer functioning as the central system.

The following definitions of terminal and station are provided to aid the reader in understanding the subject of data communications.

DEFINITION OF THE TERM "TERMINAL"

A terminal is defined as any device that can transmit or receive data through the communications lines of a Datacomm system.

DEFINITION OF THE TERM "STATION"

A station is a logical concept, unlike a terminal which is a physical concept. Every station associated with a Datacomm system must be described in the Network Definition Language (NDL) source program. A station is "described" to the Datacomm system by assigning a set of attributes to it. Every station must be given a name (i.e., a "station identifier" attribute) and a terminal species attribute. The station identifier is a logical attribute and the terminal is a physical attribute. Other logical and physical attributes are assigned to each station to define how the Datacomm system should interact with each station.

A station can be associated with a Datacomm line (explained later in this section), but it need not have such an association. However, until such an association is made, the B1800/B1700 Data Processing System cannot communicate with a station. The line to which the station is associated (if any) is not a station attribute. A station may be moved dynamically (i.e., during the continuous operation of the Datacomm system) from one line to another (or from one line to no line) and still be considered the same station.

A "multiple station line" is a Datacomm line that can have more than one station associated with it at any instant in time. Every station that can be associated with a multiple station line must have a "station address" attribute assigned to the station. Every station assigned to a multiple station line must have identical station address formats (e.g., one-character address, two-character address, or three character address). All of the stations associated with a multiple station line, at any instant in time, must have unique station addresses.

The B1800/B1700 Data Communications System can communicate with a particular station attached to a multiple station line, but only if the logical station address and the physical terminal address are identical. The station address is determined by the field engineer or if the terminal is programmable, by what the programmer has specified the address to be. The Datacomm system does not attempt to communicate with a terminal, but does attempt to communicate with a station.

TRANSMISSION LINES

Connecting the hardware components of a Datacomm system is usually accomplished by transmission lines, for example, telephone lines. These transmission lines may be either normal (switched) lines, special (leased) lines, or direct-connect.

Switched lines use the switching equipment of telephone exchanges for message routing; consequently, the physical path of the transmission can vary widely.

Leased lines are permanent or semi-permanent connections and are advantageous in that they usually permit data transmission at a higher rate of speed.

Direct-connect lines are twisted-wire pairs, normally, and are used for data transmission over short distances, as when terminals are in the same building as the central computer.

DATA SETS

In most Datacomm systems, data sets must be used to transform the digital signals generated by computers or terminals to analog signals suitable for transmission. This transformation is referred to as modulation and demodulation and has no overall effect on the system.

ADAPTERS

An adapter is an electronic interface between a data transmission line and a part of the Datacomm system. Adapters perform character assembly, timing comparison, block parity checking, block parity generation, and other logic operations. All adapters operate in half-duplex mode and present the same interface to the Single-Line Control or Multi-Line Control.

The adapters are designed to operate over the communication facilities defined in table 3.1.

DESIGNATION	BANDWIDTH	TRANSMISSION RATE	REMARKS
NARROWBAND	Variable. Usually up to 300 Hz.	150-300 bits/second.	Usually a leased line.
VOICEBAND	Nominal 4kHz.	600/1200/1800/2000/2400/4800/9600 bits per second.	Leased and switched lines.

Table 3.1 Transmission Facility Classification

All adapters accumulate one character of data before notifying the I/O control. The three types of standard adapters are described in the following subsections.

STANDARD SYNCHRONOUS ADAPTER

The Standard Synchronous Adapter provides for a connection of terminals via the following services and Burroughs data sets. Data sets equivalent to those listed below can also be used. Both an RS232C and a CCITT interface are provided. The clock pulse is supplied by the data set. Table 3.2 indicates the transmission speeds and the line service applicable for several Burroughs data sets.

Transmission Speed (BPS)	Service	Burroughs Data Set
2000	Switched	TA 734-24
2400	Leased	TA 734-24
4800	Leased	TA 733-48

Table 3.2 Standard Synchronous Adapter Data Set Interface

STANDARD ASYNCHRONOUS ADAPTER

The Standard Asynchronous Adapter provides for a connection of the terminals by the services and Burroughs data sets listed in table 3.3. Data sets equivalent to those listed can also be used. Both an RS232C and a CCITT interface are provided. The adapter is "strapped" (hardware-wired) by a field engineer to accommodate any one of the listed transmission speeds. Table 3.3 indicates the transmission speeds and line service applicable for several Burroughs data sets.

Transmission Speed (BPS)	Common Carrier Service	Burroughs Data Sets
150	Switched	TA 714
150	Leased	TA 713/753
300	Switched	TA 714
300	Leased	TA 713/753
600	Switched	TA 714
600	Leased	TA 713/753
1200	Switched	TA 714
1200	Leased	TA 713/753
1200	Leased	TA 783

Table 3.3 Standard Asynchronous Adapter Data Set Interface

STANDARD DIRECT ASYNCHRONOUS ADAPTER

The Standard Direct Asynchronous Adapter provides for a connection of terminals by a two-wire direct interface. The adapter is wired by a field engineer to accommodate any one of the transmission speeds shown in table 3.4.

Transmission Speed (BPS)	Cable Length
150	Up to 1000 feet
300	Up to 1000 feet
1200	Up to 1000 feet
1800	Up to 1000 feet
2400	Up to 1000 feet
4800	Up to 1000 feet
9600	Up to 1000 feet

Table 3.4 Standard Direct Asynchronous Adapter - Cable Lengths

In all cases the transmission code is ASCII-7 1967. The seven data bits are transmitted least-significant bit first, followed by one parity bit. The character parity is odd for synchronous operation and even for asynchronous operation.

CONTROL CODES

Control codes are recognized by the adapters and are used in the Datacomm system for character synchronization, to indicate where a message begins and ends. They are also used as a response to indicate the success or failure of the last transmission.

The adapters recognize the control codes listed in Table 3.5. The corresponding function of each control code is also listed.

Function	Control Code
Synchronization	SYN
Start	SOH, STX
Ending	ETX, ETB
Positive Response	ACK, ENQ, BEL, ETX, ETB
Negative Response	NAK, EOT (optional), TIMEOUT (optional)

Table 3.5 Control Codes for Standard Adapters

Synchronization Control Code

Synchronization control codes (SYN) are not stored in memory. Two SYN control codes must be received before a Standard Synchronous Adapter will recognize any other control codes in memory, except SYN, up to but not including a Block Check Character (BCC). A synchronization code is not included in a BCC sum. At least four synchronization control codes must be transmitted prior to data transmission. These codes are automatically generated by the adapter prior to the data transmission.

Start Control Codes

The start control code (SOH or STX) is used to start the accumulation of a BCC with the next non synchronization character received by the adapter. After the receipt of a start control code, only those control codes classified as ending control codes terminate the operation.

Ending Control Codes

The ending control code (ETX or ETB) is used to finish the transmission of the message and end the accumulation of the BCC. Following the ending control code, the BCC will be the next character transmitted if the I/O operation is a write. If the I/O operation is a read, the BCC will be the next character expected after the ending control code is received.

Positive and Negative Response Control Codes

A positive response control code, unless also classified as an ending control code, does not terminate an I/O operation of the positive response code if preceded by a start control code.

A control code that is classified as a positive response or a negative response is defined to be an ending control code, but only if it is not preceded by a start control code.

An option is provided to ignore EOT (End of Transmission) as a negative response control code for read and write operations. On read operations this option allows the I/O control and the system to which it is attached to act as a terminal, and to receive a polling sequence from other data communications systems. No hardware recognition of addresses is provided. On write operations this variant allows the I/O control to ignore EOT in order to transmit polling sequences and other sequences which use EOT as the first control code in a message as a line-clearing code.

BLOCK CHECK CHARACTER (BCC)

A Block Check Character is normally transmitted following all messages that contain a start control code. The BCC is formed by taking the modulo 2 sum for each data bit following a start control code, up to and including an ending control code. The BCC is transmitted after the ending control code with appropriate character parity. A field engineer can wire the adapter to exclude the generation and checking of a BCC.

I/O DESCRIPTORS

The I/O descriptor is the basic communications link between the B1800/B1700 system software and hardware. Figure 3.1 illustrates the I/O descriptor format used in Datacomm. All fields are 24 bits in length.

E FIELD = ENDING ADDRESS
RS FIELD = RESULT STATUS INFORMATION
L FIELD = LINK ADDRESS POINTING TO THE RS FIELD OF THE NEXT I/O DESCRIPTOR IN THE LIST
OP FIELD = OPERATION, VARIANTS, AND ADAPTER NUMBER
A FIELD = STARTING ADDRESS OF DATA
B FIELD = ENDING ADDRESS OF DATA

Figure 3.1 I/O Descriptor Format

OP Field

The OP field must be set up by the system software before an I/O operation is initiated. The operation requested, any variants to the operation, and the adapter identification number (if applicable) are contained in this field.

The high-order (leftmost) three bits of the OP field contain the operation code for either a READ, WRITE, BREAK, PAUSE, STOP, or TEST. The next 17 bits are used for variants of the operation. For example, a write operation and a write with translation operation would have the same operation code, but the write with translation operation would have a variant bit set to cause the operation to be modified.

The low-order (rightmost) four bits of the OP field identify the unique adapter connected to the I/O control for this operation.

A Field

When the operation specified in the OP field requires character transfers to or from memory, the A field must contain the starting address in memory where the I/O control can fetch or store characters. When the A field is required, it must be set up by the system software before it initiates an I/O operation. The A field must define a non-zero integer number of eight-bit bytes.

B Field

The B field is required whenever the A field is required. The B field contains the address of the last character position in memory for I/O control access. The B field contents (ending address) must be greater than the A field contents (beginning address). On read operations the B field must be large enough to provide space for all characters expected to be read. When the character specified by the B field address has been transferred, the I/O control terminates the operation.

L Field

The L field holds the address of the RS field of an I/O descriptor. Linking is a technique used to execute two or more I/O operations consecutively without intervening system software execution. However, the link could be to the RS field of the same descriptor. Both the SLC and MLC (explained later in this section) require that all I/O descriptors be linked, except when the stop operation is used. Upon completion of the I/O operation (if the operation was not a stop operation and if no error occurred), the I/O control fetches the address of the RS field of the next I/O descriptor from the L field. The I/O control then checks the operation complete bit of the next I/O descriptor, and initiates the next operation requested if the bit is FALSE.

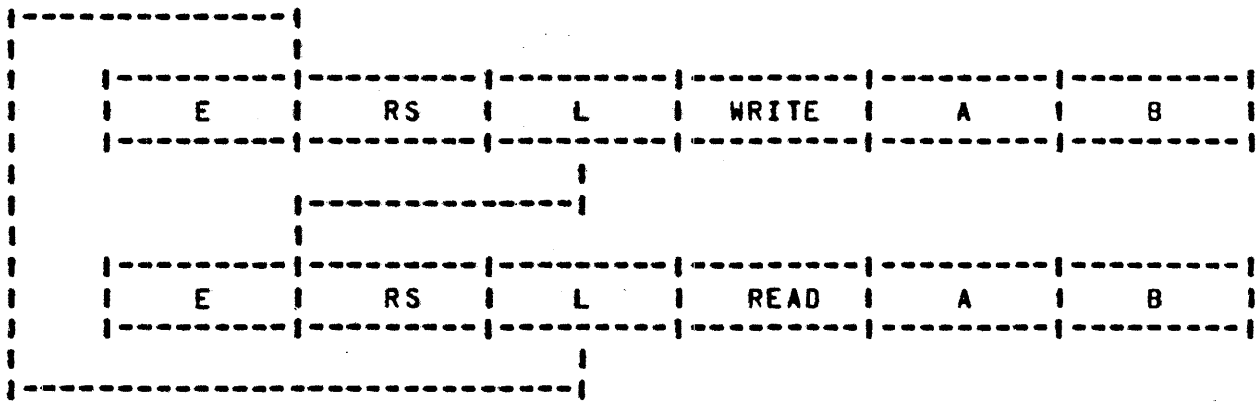

Figure 3.2 I/O Descriptor Linking

A simple write operation linked to a read operation, which is very common in Datacomm operations, is illustrated by figure 3.2. Assume that the system software has cleared the RS field, set up the L, OP, A, and B fields, and stored the address of the RS field of the write descriptor in absolute memory location 0.

Upon receiving an interrupt, the I/O control fetches the RS address of the write I/O descriptor, and the operation requested is initiated since the operation complete bit is FALSE.

When the write operation is complete and if no error occurred, the I/O control fetches the address of the read descriptor from the L field of the write descriptor. Since the RS field had been previously cleared, the read operation is initiated.

When the read operation is complete and if no error occurred, the I/O control fetches the address of the RS field of the write descriptor from the L field of the read descriptor. Because the write operation had been completed previously, the I/O control does not initiate the write until the operation complete bit is reset.

The linked list of I/O descriptors shown in figure 3.3 is similar to those shown in figure 3.2. The read descriptor is linked to the descriptor for a stop operation, so that no further linking is performed by the I/O control.

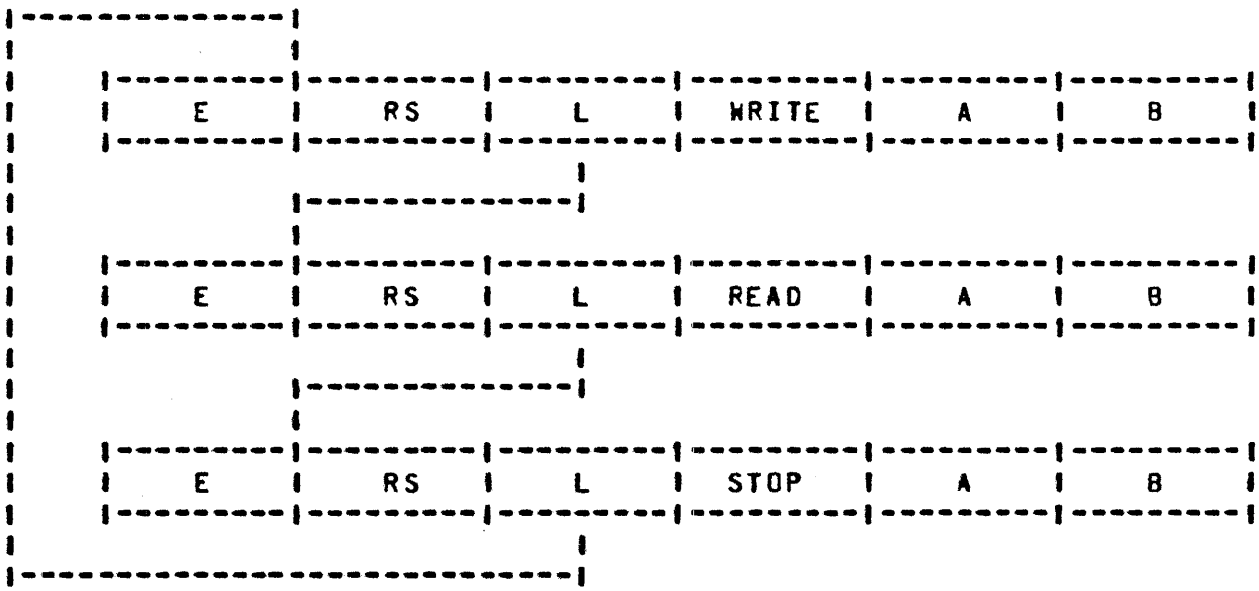

Figure 3.3 Linking to a Stop Operation

Figure 3.4 illustrates an operation using only one descriptor that is linked to itself. As a result, the I/O control pauses after completing the operation.

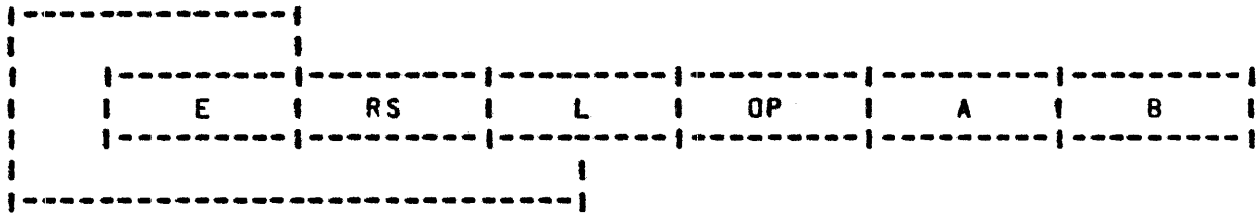

Figure 3.4 Linking to the Same Descriptor

E Field

The E field is initialized and used by the hardware during the operation and can be used by the system software upon completion of the operation. For read and write operations, the hardware stores the incremented A field address in the E field. After a write operation, the E field normally points to the next bit following the ending code. After a read operation, the CSM stores the final incremented A field address pointing to the memory location where the next character of data would normally be stored.

Upon completion of a read or write by the hardware during the operation, the system software can use the E field for message length computation. For example, the E field address less the A field address divided by 8 equals the number of characters read or written.

RS Field

The I/O control Uses the RS field for three functions:

a. To determine when to initiate the operation.

b. To provide temporary storage during execution of an operation.

c. To provide storage for the result status information after completion of an operation.

Prior to, and during an operation, the first 15 bits of the RS field are used to store temporary flags for the CSM, and the last nine bits are used to indicate dynamic interrupt information.

The system software should clear the result status bits before initiating the I/O operation. The I/O control may not initiate an I/O operation when the operation complete bit is TRUE (1). (See the I/O control descriptions for further information.) The operation complete bit is the first of the result status bits and is used by the I/O control in I/O descriptor linking.

The meaning of the individual bits for the result descriptor, stored in the RS field of the I/O descriptor, is defined in table 3.6.

Bit	Meaning
0	Operation complete
1	Exception condition
2	Reserved
3	Parity error
4	Memory access error (Read)
5	Memory parity error (Write)
6	TIMEOUT
7	BREAK received
8	No ending control code
9	Chaining terminated
10	Not used
11	Loss of "Data Set Ready"
12	Loss of "Clear to Send" (Write) or Loss of "Carrier (Read)
13	Not used
14	Not used
15	Reserved
16	Operation complete
17	Data Communications device
18-23	Adapter identification

Table 3.6 Result Status Bits for Standard Adapters

I/O CONTROLS

Two types of Datacomm controls are used with B1800/B1700 Data Communications System: the Single-Line Control (SLC) and the Multi-Line Control (MLC). To the Datacomm system software both I/O controls function the same and have the ability to access the adapters and main memory. (Refer to the B1800/B1700 Systems Reference Manual, Form No. 1057155 for information concerning main memory and control memory.) The I/O control itself is sensitive to I/O commands and accumulates characters from adapters to build messages. The I/O control processes the accumulated characters, and initiates various functions as specified by the system software.

The I/O controls can interrupt the system software for notification of the I/O completion. After executing an I/O operation, the I/O control stores a 24-bit result descriptor in the Results Status (RS) field of the I/O descriptor. This I/O descriptor can then be used by the system software to determine what action, if any, should be taken.

On write operations, the I/O controls have the capability to translate B1800/B1700 EBCDIC code to ASCII code, and on read operations, from ASCII code to EBCDIC code.

The I/O controls can execute the AUTOPOLL function, which allows the I/O control to continuously poll (request input from) stations on a line without interrupting the Master Control Program.

The Single-Line Control and Multi-Line Control each operate with all defined adapters for the B1800/B1700 system.

SINGLE LINE CONTROL

Figure 3.5 shows the relationship of the Single-Line Control to pertinent hardware units of the B1800/B1700 system.

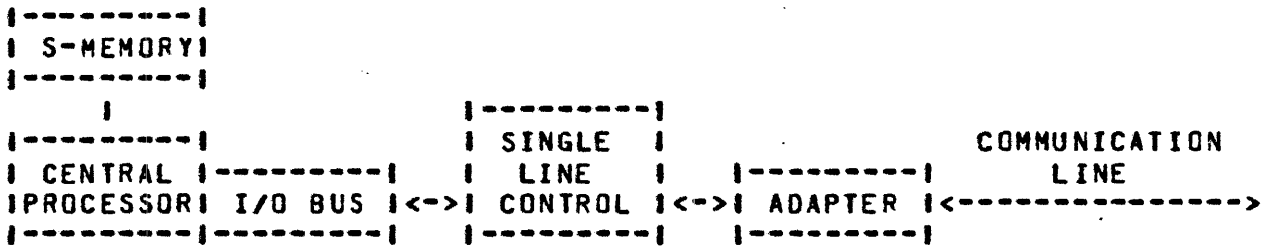

Figure 3.5 SLC Hardware Organization

One Single-Line Control and one adapter service one communication line. The SLC provides two buffers of 13 bytes each, which are used in a cyclic manner to receive data during data transfer operations. Any data loss resulting from a buffer being unavailable is flagged as a memory access error.

Data is transferred between the system and the I/O control in 8-bit parallel fashion. The Single-Line Control operates with a system clock frequency of 2, 4, or 6 megahertz.

Functions Of The Single-Line Control

The Single-Line Control provides the following basic functions for each adapter:

a. Data buffering

b. Interface to CSM

c. Reference address storage for an adapter

d. Initiation of an adapter to an appropriate operating mode

e. Servicing requests for character transfer

f. ASCII-7 to/from EBCDIC translation as selected by variant

g. Result status reporting

h. AUTOPOLL

Functional Description - Single-Line Control

The Central Service Module (CSM) assumes that a linked list of I/O Descriptors is available to itself. The CSM is initiated by the receipt of a 24-bit address which points to the RS field of an I/O descriptor. The CSM inspects the first two bits of the RS field and, if they are equal to "00", exchanges them with the literal "01" from a storage area. If the exchanged bits are still equal to "00", the CSM initiates the I/O control with the indicated operation. If the first two bits of the RS field are not equal to "00", the CSM initiates a pause operator to the I/O control. After the completion of the pause operator, the CSM repeats the inspection on the same I/O descriptor. After completion of an operation, this procedure is again repeated by using the link address as a new address. Note that if a locked descriptor is dispatched to the Single-Line Control it will not initiate it due to the fact that it examines the first two bits in the RS field before initiation. Instead, it will initiate a pause as described.

The following are exceptions to the above conditions and operations:

a. If the result has an exception condition, the CSM forces the I/O control to go idle after returning a result and an interrupt.

b. If the CSM receives a stop operation code, the CSM forces the I/O control to go idle after returning a result, and returns an interrupt if applicable.

c. If the CSM receives a memory parity error signal during the fetch of an I/O descriptor (RS, OP, A, B, C, RS swap, or link fields), or during the fetch of the start address, the CSM sends a special interrupt message to port number 0, channel number 15, consisting of an address pointing near the field in error. The CSM then exits.

At the completion of an operation, and after the actual ending data address is stored, the information in the RS field is exchanged with the result status bits from the operation.

The information read from the result status field includes one interrupt request bit, one high-interrupt bit, a 3-bit port number, and a 4-bit channel number. If the interrupt request bit is TRUE, the CSM generates an appropriate interrupt message to the port indicated.

If the interrupt request bit is FALSE, the CSM generates an interrupt message only if the result status bits returned had exception bit number 2 set.

The interrupt message is a 24-bit address pointing between the result status bits and the link address. The channel number contained in the result status area (normally the channel number of of the I/O control which received the I/O descriptor) is also returned to the port indicated.

Figure 3.6 shows the location of the various bits (that are inspected by the CSM) in the result status area prior to storage of the result.

Figure 3.6 Result Descriptor - Single-Line Control

When the Single-Line Control sequences through the status states, which involve the returning of a result, various bits in the result field are used by the CSM to enable or disable the storage of the result and to take other action.

These bit combinations and meanings are as follows:

Bit Combinations 17	23	24	Meaning to CSM
0	0	0	The CSM does not store a result, but proceeds to the next I/O descriptor. The combination of bits 17, 23, and 24 is used by a read operation (poll) after a negative response with no errors.
0	0	1	The CSM does not store a result, but moves the address from the A field into the E field if the final address in the E field is equal to the terminating address in the B field. The CSM then proceeds to the next I/O descriptor. The combination of bits 17, 23, and 24 is used by a write operation (poll) in order to restore the pointer to the beginning of the poll list in the absense of error conditions.

MULTI-LINE CONTROL (MLC)

The Multi-Line Control services up to 16 communication lines and requires one adapter per line. The Multi-Line Control can be used only with the B1720 Series system. The first eight lines and adapters are serviced by the B1352 Multi-Line Control, and an additional eight lines and adapters can be served by the B1353 Multi-Line Control Extension, which can be cabled to the B1352 Multi-Line Control.

Figure 3.7 shows the relationship of the Multi-Line Control to pertinent hardware units.

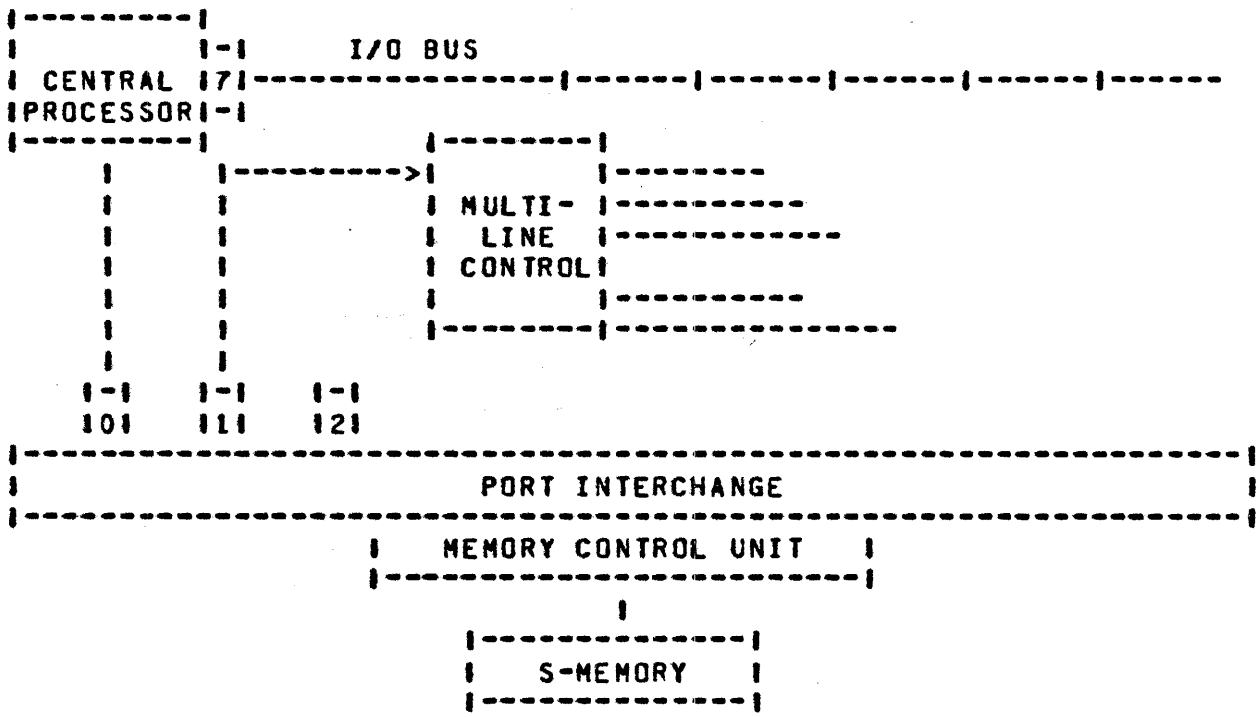

Figure 3.7 MLC Hardware Organization

The Multi-Line Control operates on a 6-megahertz clock frequency. The MLC employs a scanning technique to detect adapters that require servicing. The time required for servicing depends upon the number of adapters simultaneously requesting service and the position of the requesting line relative to the scanning pointer. The scanning is continuous, and requires approximately 32 system

clock pulses to scan a complete set of 16 adapters without servicing any of them. Servicing an adapter takes between 2 and 10 system clock pulses. To detect and service an adapter requiring attention takes an average of 24 system clock pulses.

The Multi-Line Control employs scanning in servicing memory accesses for the buffers in control. Data is stored/fetched, eight bits per memory access, in parallel fashion.

One character of buffering per adapter is provided in the Multi-Line Control, in addition to the one character accumulated by the adapter.

Functions of the Multi-Line Control

The Multi-Line Control provides the following basic for each adapter:

a. I/O initiate handling

b. I/O descriptor fetch for an adapter

c. L, A, and B descriptor address storage for an adapter

d. Adapter initiation to an appropriate operating mode

e. Servicing requests for character transfer

f. ASCII-7 to/from EBCDIC translation as selected by variant

g. Result status and interrupt message-handling

h. Linking

i. AUTOPOLL

Functional Description - Multi-Line Control

Input/output is initiated by the receipt of an interrupt signal indicating that a 24-bit message is present starting at absolute memory location 0. The message is an address that points to the RS field of an I/O descriptor. The MLC fetches this address by executing a read and clear operation.

The Multi-Line Control then fetches the descriptor that directs the I/O operation to the adapter specified in the OP field of the I/O descriptor.

The initial I/O descriptor sent to an adapter must be ready for execution. The operation complete bit of the RS field must be set to 0. On a dispatched descriptor, the MLC does not inspect the first two bits of the RS field before initiating the operation. This is different from SLC operation.

Following execution of the initial I/O descriptor, the MLC fetches the link address which points to the RS field of the next I/O descriptor in the chain. The MLC then checks the operation complete bit in the RS field of the descriptor. If OC = 0, the MLC fetches the remainder of the descriptor and performs the operation indicated by the OP field. If the OC = 1, a pause and inspection procedure is performed at 8 to 12-millisecond intervals until OC = 0. This procedure is repeated after the completion of each operation.

The following are exceptions to the above conditions and operations.

a. If the result has an exception condition, the MLC for the applicable adapter goes idle, after returning the result status information and an interrupt.

b. If the MLC receives a stop operation code, it will go idle for that adapter, after returning a result and an interrupt if applicable. All adapters must be idle for the MLC to go idle.

c. If the MLC receives a memory parity error signal during the fetch of any I/O descriptor fields or during the read and clear message operation, the MLC sends a special interrupt message to port number 0, channel number 15, consisting of an address pointing beyond the field in error.

The MLC accepts all I/O initiate interrupts directed to it, regardless of the state of an adapter. If an I/O initiate is directed to a busy adapter, the MLC forces the adapter to the new operating state, thereby destroying all traces of the previous operation, including a pending interrupt message.

After the completion of an operation and after the actual ending data address has been stored, the information in the RS field of the descriptor is exchanged with the result status bits from the operation by execution of a memory swap operator.

The information read from the result status field includes one interupt request bit, one high interrupt bit, one 3-bit port number, and one 4-bit channel number. If the interrupt request bit is TRUE, the MLC generates an appropriate interrupt message to the port indicated.

If the interrupt request bit is FALSE, the MLC generates an interrupt message only if the result status bits returned have exception bit number 2 set.

The interrupt message is a 24-bit address pointing between the result status bits and the link address. The channel number contained in the result description status area is normally the channel number of the MLC which received the I/O descriptor. This channel number is returned in any message generated by the control.

Figure 3.8 shows the location of the various bits in result status area that are inspected by the MLC.

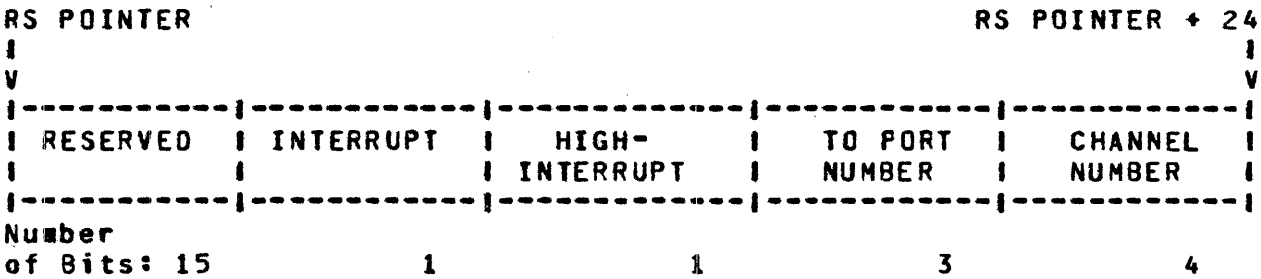

Figure 3.8 Result Descriptor -- Multi-Line Control

The Multi-Line Control, servicing a write interrupt message, has the ability to stop servicing the write interrupt message and to service a normal memory request of a read and clear message operation any time the interrupt register is in use (locked). The MLC is permitted to stop servicing a write interrupt message only during the period that the lockout signal is TRUE, but this must occur, however, before the memory cycle has been granted to the MLC.

B1800/B1700 SYSTEM DATA COMMUNICATIONS SOFTWARE DESCRIPTION

The B1800/B1700 Data Communications System (Datacomm) operates asynchronously with the Master Control Program (MCP), providing efficient multiprogramming of data communication functions with on-site production jobs. The Datacomm system software consists of three different modules or programs: the Network Controller, the Message Control System, and application programs. The Network Definition Language and the Network Controller are described briefly in this section. Refer to the B1800/B1700 Systems Network Definition Language (NDL) Reference Manual, Form Number 1073715, for detailed information concerning this language. The Message Control System, which is optional for a Data Comm system, is described in this section and in P.S. 2219 0482, Supervisory Message Control Systems. The remote file syntax for COBOL, RPG and UPL, and a discussion of station numbering are also included in this section.

NETWORK DEFINITION LANGUAGE

The B1800/B1700 Network Definition Language (NDL) is classed as both a descriptive language and a programming language. It is a high-level language for data communications and provides a simple means of generating a B1800/B1700 Network Controller (discussed next). The programmer defines a Datacomm network by specifying the network attributes in NDL source code, which includes a description of the physical devices in the network, the line disciplines to be used, the order and priority of the use, and the grouping of stations into files.

If the physical data communications network is reconfigured, the user can easily change the attributes that describe the network in the NDL source program, and recompile to produce the desired Network Controller. To simplify the task of the Datacomm system user, the NDL Compiler maintains a set of standard routines on disk to handle common line disciplines. NDL can also accommodate a user-written Message Control System (MCS) when certain functions and Datacomm decisions need to be controlled.

NETWORK CONTROLLER

The Network Controller (NC) is the heart of the Datacomm system, and its function is to process and supervise the flow of messages between application programs and the remote network. The B1800/B1700 NDL Compiler translates the source code and, from it, produces the Network Controller codefile and the Network Information File (NIF). Figure 4.1 illustrates the NDL generation process.

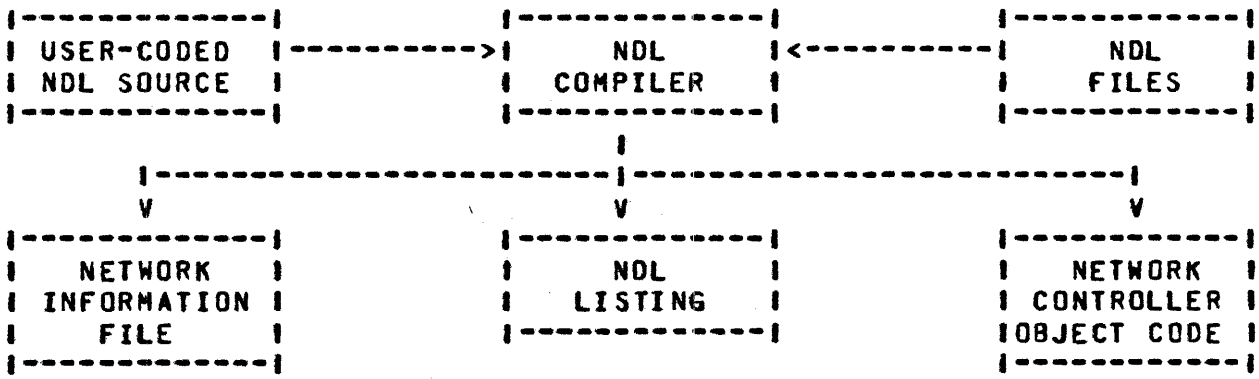

Figure 4.1 NDL Generation Process

The Network Information File (NIF) contains tables that describe the physical and logical attributes of the network. The initialization values for the LINE, STATION, TERMINAL, and FILE tables of the Network Controller (NC) are contained in the Network Information File.

The Network Controller is a normal-state program that performs the line discipline, queuing, buffer management, and audit and reconfiguration functions required by Datacomm systems. The Network Controller may be considered to be a user-defined extension of the operating system (MCP). The Datacomm input/output actions are performed directly by the Network Controller and all peripheral input/output functions for all batch programs are performed by the MCP.

The Network Controller performs its functions through the use of user-supplied information and system-supplied routines. The user information, provided by the NDL source program, concerns lines, stations, terminals, line control, line discipline, and

interrelated aspects. The system-supplied routines provide for I/O initiation, I/O completion, entrance to user CONTROL and REQUEST procedures, communications with the application programs and the MCS.

When a message is received from a station, the Network Controller (NC) queues it for the MCS or the application program. When a message is received from an application program or the MCS, the NC initiates the appropriate procedures to transmit the message to the station. The NC also takes care of simultaneous I/O, multiple lines, recovery from line errors, and auditing, if required.

NDL is also used to define other attributes of the B1800/B1700 Data Communications network. Thus, NDL provides a description of the line adapter configuration, the configuration of data sets, each terminal species, each station, and the line disciplines that are used with the lines and stations of the network.

The physical attributes that must be described for each station in the NDL source program are the station terminal species and the station adapter type. The station address is another physical station attribute that can be described.

For additional information concerning the Network Definition Language refer to the B1800/B1700 Systems Network Definition Language (NDL) Reference Manual, Form Number 1073715.

APPLICATION PROGRAMS

The B1800/B1700 users' application programs for Datacomm may be written in COBOL, RPG, or the User Programming Language (UPL) source code. When the source code is complied, the resulting application program is to process the input/output data in terms of the problem to be solved and does not have to be concerned with the minute details of the data communications network. The function of the application programs is to process the input/output data according to applicaton considerations, as in normal batch processing. The data is contained in the text of messages.

Because of the functions provided in the MCS and the Network Controller, the application program can deal with communication

devices in the same manner as with conventional devices such as card readers, line printers, and magnetic storage devices. The Network Controller provides the interface between the application program and the remote network. Application programs are linked to the Network Controller by the file name in the FILE Section of the NDL program.

Figure 4.2 illustrates the relationship of an application to the Network Controller and to the remote devices of a Datacomm network.

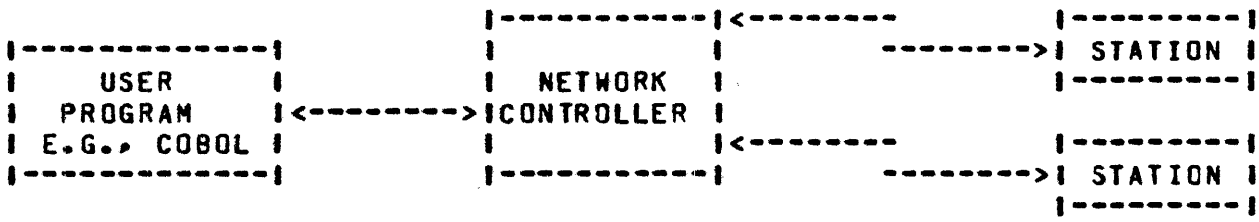

Figure 4.2 Datacomm Program Relationship

An application program can open a remote file through which several stations are accessible. These stations are said to be members of a family of stations and constitute attributes of the file. If an MCS is present, stations can be added to or deleted from the family while the file is open. The stations of a family need not have the the same terminal type. The FAMILY statement in the FILE section of the NDL program is used to list the names of the stations that are members of the file being described.

DATACOMM REMOTE FILE SYNTAX

When using a Datacomm network, the user must declare his file REMOTE. The remote files are used for communication between an application program and the remote terminals by way of NDL-compiled Network Controller. The application program treats the remote files as it does any other file. The Message Control System (MCS) uses the "HEADERS" option for remote files.

The remote file syntax for COBOL, RPG, and UPL is described on the following pages. Following those descriptions is an explanation of station numbering.

Examples of several application programs written in COBOL are included in appendix B.

COBOL Remote File Syntax

Extensions to B1800/B1700 COBOL permit users to OPEN, CLOSE, READ, and WRITE remote files. These extensions involve the FILE-CONTROL SECTION of the ENVIRONMENT DIVISION, the FILE SECTION of the DATA DIVISION, and the PROCEDURE DIVISION. Following is the syntax to be observed for each division. The underscored words in uppercase type are required by the COBOL language syntax.

a. FILE-CONTROL SECTION (ENVIRONMENT DIVISION)

```
SELECT file-name ASSIGN TO REMOTE. [WITH HEADERS]
ACTUAL KEY IS data-name. (Optional)
```

The remote file is identified by the SELECT file-name ASSIGN TO REMOTE statement. When this file is opened in the PROCEDURE DIVISION of the application program, a message is sent by the MCP to the Network Controller, which will attach a family of remote stations to the file. The file-name from the SELECT statement is used unless the VA of ID (see point b, below) is present in the FILE SECTION of the DATA DIVISION; the file-name must match a family in the FILE Section of the NDL program.

The ACTUAL KEY option may be used with the remote file to selectively identify one station in the remote file. If the key is specified , it must have the following format:

```
01  REMOTE-KEY
    03  STATION-RSN    PC 9(3).
    03  TEXT-LENGTH    PC 9(4).
    03  MSG-TYPE       PC X(3).
```

STATION-RSN refers to the Relative Station Number of the station in the remote file.

TEXT-LENGTH defines the text size, in characters, and should never be larger than the largest 01 level item declared for the

file. If TEXT-LENGTH is larger than the largest 01 level item, data will be truncated from the low-order portion.

MSG-TYPE is set to a 1 by the Network Controller for a read operation. On a write operation, MSG-TYPE must be set to 0 in the application program, unless an MCS is participating and explicitly changes the value.

The level specified for the remote key does not have to be 01, but the group length must be 10. A syntax check is done only on the group length.

All other FILE-CONTROL clauses are ignored for remote files.

b. FILE SECTION (DATA DIVISION)

```
FD
FILE CONTAINS integer -----| STATION
                           | STATIONS
VA OF ID -----| data-name
              | literal
```

The CONTAINS clause specifies the number of stations and must match a file name in the FILE section of the NDL program. The VA OF ID statement is optional.

VA OF ID can be used to declare an external file name for remote files, just as it can for other types of hardware, such as magnetic tape units, disk devices, line printers, and card readers.

c. PROCEDURE DIVISION

```
          | INPUT
OPEN -----| INPUT-OUTPUT    remote-file-name
          | OUTPUT

WRITE-----| remote-file record      [FROM        data-name]
                                    [INVALID KEY statement]

READ------| remote-file             [AT END statement]

CLOSE-----| remote-file-name
```

The OPEN verb opens the named file and causes stations to be attached to it. A remote file can be opened INPUT, OUTPUT, or INPUT-OUTPUT.

WRITE gives text from the remote-file record area or from data-name to the Network Controller for subsequent transmission to the station or stations. READ waits for the Network Controller to pass any text received from one of the stations in the remote file. If ACTUAL KEY is used in the FILE-CONTROL SECTION, ACTUAL KEY will be modified when text is received to contain information about the station and text. If AT END is present, the AT END statement is executed when directed by the Message Control System, or by the Network Controller at shutdown time, when the B1800/B1700 computer operator enters a "QC" keyboard input message from the console printer.

Note: Exception conditions for the READ verb must be tested by the USE AFTER STANDARD ERROR PROCEDURE ON file-name.

CLOSE detaches the stations and closes the remote file.

RPG Remote File Syntax

In the RPG source program, a Datacomm file specifier is declared with the following differences:

a. The word REMOTE must appear starting in column 40 of the File Description card. The number of buffers is permitted for demand files in column 32. Allowable types and designations (columns 15 and 16) must be Input-Demand, Combined-Demand, or Output.

b. A Telecommunication Specifications card must follow the File Description Specification card. The Telecommunication Specification card must contain the following:

Card Column	Contents	Meaning
6	T	For Telecommunicaton.
7-14	File name	
16 - 18		Number of stations.
19 - 21		Maximum number of messages undelivered (2 to 255)
22 - 27		Identifier accessible by program, contains 3 character station number.
28 - 33		Identifier accessible by program, contains 4 character message size (in characters)

c. In the CALC specifications, receiving from and transmitting to terminals is performed via the RECV and SEND operations.

Note: See the RPG Manual for more details.

UPL Remote File Syntax

The UPL remote file syntax, which is somewhat similar to COBOL syntax, includes file declarations and the OPEN, CLOSE, READ, and WRITE verbs.

The FILE statement and the options used for remote files are described below.

```
FILE  internal-file-name  (DEVICE=REMOTE(<NUMBER>)[WITH HEADERS]
                           [,REMOTE.KEY]
                           [,NUMBER.OF.STATIONS=<NUMBER>]
                           [,BUFFERS=<NUMBER>])
```

The REMOTE.KEY attribute indicates that a key is present for a read or write operation to the file. If this attribute is not specified, a key cannot be used. Each field of the key is in decimal characters. The key is comprised of 10 characters and has the following format.

```
01  KEY.INFO                   CHARACTER (10),
    02  STATION.NUMBER         CHARACTER  (3),
    02  TEXT.LENGTH            CHARACTER  (4),
    02  MESSAGE.TYPE           CHARACTER  (3),
```

The <NUMBER> following the device type "REMOTE" indicates the maximum number of messages that will reside undelivered at one time in the remote file. This includes all messages destined either for a station (output) or from a station (input).

The "BUFFERS" statement specifies how many of the undelivered residing messages will be kept in memory at one time. Any excess (more than "BUFFERS" but not more than <NUMBER> in "DEVICE" statement) will reside on disk.

NUMBER.OF.STATIONS specifies the number that can be attached to this file as provided for in the Network Controller.

The following is the syntax for READ and WRITE verbs for use with remote files:

```
READ internal-file-name ["["<remote-key>"]"] (area) [ON EOF statement;]
                                                    [ON EXCEPTION statement;]
WRITE internal-file-name ["["<remote-key>"]"] (area);
```

Remote-key must be present if REMOTE.KEY is specified in the FILE statement.

On a READ remote, the key contains the data described by the REMOTE.KEY attribute that pertains to the message just read. If the file is empty, the program is suspended until a message is present.

ON EOF is executed when directed by the Message Control System, or by the Network Controller at shutdown time when the B1800/B1700 operator enters the "QC" console input message.

If the ON EXCEPTION option is specified, it will be executed when an irrecoverable I/O error occcurs on a READ.

Station Numbering

There are two types of station numbers used in B1800/B1700 Datacomm: Relative Station Number (RSN) and Logical Station Number (LSN).

Relative Station Numbering

A given remote file may contain one or more stations; reference to these stations is by RSN within the file. The RSN is determined by the order in which the station is defined by the FAMILY statement in the FILE Section of the NDL program, or by the order in which the Message Control System attaches the stations to the file.

Example:

```
FILE TEST:
     FAMILY = S1, T3, S7.
```

Station S1 would be relative station number 1, because it is the first station defined. Station T3 would be relative station number 2, because it is the second station defined for FILE TEST.

Logical Station Numbering

Stations in a Datacomm network may also be identified by LSN, but only within the Message Control System. Since the MCS may participate in every message transfer, a file does not have the same meaning to an MCS as it would to an application program. Logical station number has no relationship to file names, but is determined by the order in which a station is defined in the STATION Section of the NDL program.

Examples:

```
STATION DEFAULT TD7:           % This is a list of station
        MYUSE = INPUT,OUTPUT   % defaults that may be used
        RETRY = 5.             % in subsequent station
        TERMINAL = TD700.      % definitions.

STATION TD8:                   % This is logical station
        DEFAULT = TD7.         % number 1, because it is the
        ADDRESS = "A3".        % first station defined.

STATION TD1:                   % This is logical station
        DEFAULT = TD7.         % number 2, because it is the
        ADDRESS = "A5".        % second station defined.
```

MESSAGE CONTROL SYSTEM (MCS)

GENERAL

The Message Control System is optional for the B1800/B1700 Datacomm System. The MCS, when present, controls message flow between application programs and the Network Controller. It is the responsibility of the MCS to process all messages directed to it and send them to the appropriate stations or programs. The MCS has more potential power than a normal application program and operates in conjunction with the Network Controller. Note that the NC/Network Controller interface is message oriented and that both the MCS and the Network Controller use the same message format.

The user may write the MCS in User Programming Language (UPL) or in COBOL. Which language to use is entirely up to the user; however, users should note that if the MCS is coded in the same language as the applications programs, there will not be the extra overhead of switching S-machines (interpreters) as the MCS and the applications alternately process messages.

The B1800/B1700 software release includes an illustrative MCS (MCSII) which can be used as a base for user-written MCS's and a supervisory MCS (SMCS) which is intended to be used unmodified on systems which need to interconnect many stations with various applications (such as CANDE, SYCOM, RJE or any user-written application). See the respective product specifications for further detail.

NEED FOR AN MCS

The following criteria may be used to determine whether or not an MCS is needed to control the B1800/B1700 Datacomm network:

a. Degree of sophistication of the network
b. Type of line error recovery desired
c. Need for text editing
d. Need for message switching
e. Need for dynamic network reconfiguration

MCS FUNCTIONS

The functions performed by a Message Control System are at the user's discretion and vary from application to application. Users with Message Control Systems are allowed to participate in, or rigidly control, system functions and decisions. Some examples are listed below.

a. Network reconfiguration
b. Error handling
c. Message switching
d. Pre-processing of the message

Note: For further information regarding the MCS, see Message Control Systems (MCS) Interface, (P.S. 2212 5447).

DATACOMM MESSAGE FLOW

GENERAL

The Network Controller processes and supervises the flow of messages between application programs and the remote stations of the Datacomm network. If a Message Control System (MCS) is present in the network, the MCS controls the message flow between the application programs and the Network Controller.

The data to be transferred to or from the remote devices is contained in the text messages. A message header always precedes the text of the messages. Messages can vary in size from a single character to any continuous character string that can be accommodated by the equipment. The length and content of the message text depend upon the application.

For further information see MCS Interface (P.S. 2212 5447).

The Network Controller has a queue array which has one entry for each station in the network, and one additional entry for special use, which is the first entry. For example, when the application program opens the remote file, an open indicator is placed in the first entry (entry 0 of the Network Controller queue array.

DATA MOVEMENT

Data movement in an NDL-compiled Datacomm network occurs whenever an application program or an MCS does a read or write operation. The occurrence of the data movement is indicated by the letters DM and a numeral (e.g., DM2) adjacent to an arrow. The numerals show the order in which data movement occurs.

MESSAGE: NO MCS PRESENT

Figure 5.1 illustrates Datacomm message flow when no Message Control System is present.

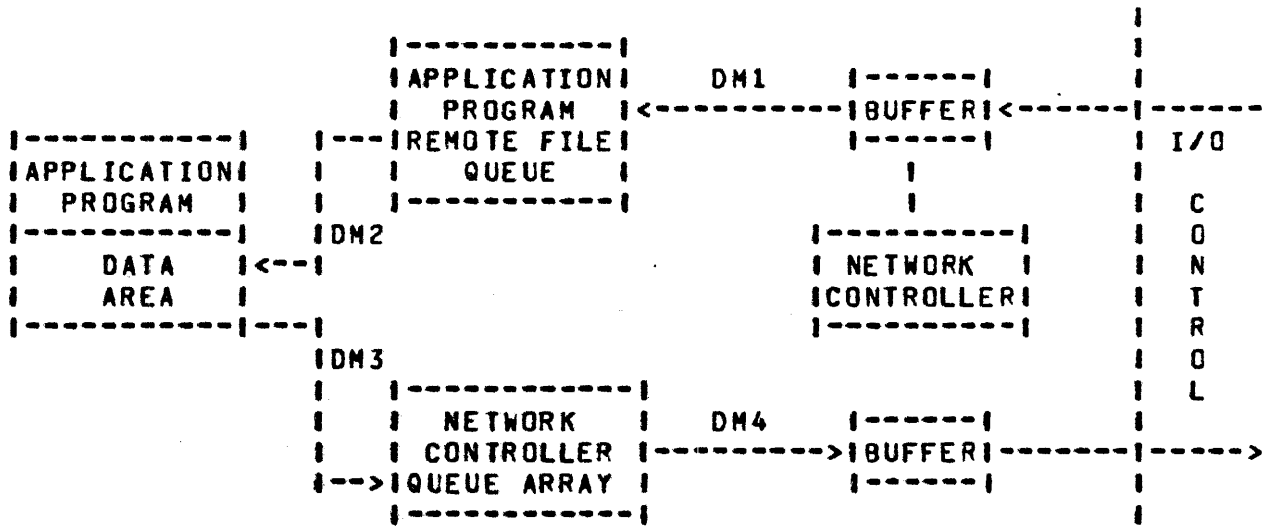

Figure 5.1 Datacomm Message Flow - No MCS

The I/O control collects the input message character(s) in a buffer. The Multi-Line Control has a one character buffer, and the Single-Line Control has two 13-character buffers. The I/O control transfers the character(s) to a buffer in memory that is large enough to hold the entire message. When the application program executes a read operation on its remote file, the MCP transfers the first input message to the record area of the application program. DM1 in figure 5.1 indicates that the first data movement occurred during the message transfer. The application program processes the message and executes a write operation in reply to the remote station. The MCP transfers the reply from the record area of the application program to the Network Controller queue array.

When an application program executes a file open operation on a remote file, the following actions take place.

a. The MCP queues a remote file open message to the Network Controller through entry 0 of the Network

Controller queue array.

b. The MCP constructs a File Information Block (FIB). The disposition of the remote file open request is not known at that time, and the application program may be suspended (rolled out of main memory) to await permission to open the remote file.

c. The Network Controller grants the file open request, and attaches the station list to the message just received from the MCP.

d. The Network Controller executes a communicate to the MCP to inform it of the approval of the file open request.

e. The MCP uses the job number to find the suspended program.

f. The MCP attaches the station list to the object program FIB and discards the message that the Network Controller sent.

g. The MCP makes an entry in its queue directory when the remote file is opened.

h. The MCP does a cause operation on the Run Structure Nucleus of the suspended program.

Note: If a file open request is executed by an application program with fewer stations declared in the application program than have been specified in the NDL source program, not all of the stations will be marked "READY" by the Network Controller. Only the stations that have the lowest relative station number (in the FAMILY statement of the FILE Section of the NDL program) will be marked "READY." For example, if five stations are declared in the applicaton program, and eight stations are specified in the NDL FAMILY statement, only the first five stations specified will be marked "READY."

A file open request will be disapproved by the Network Controller for any one of the following reasons.

a. The MYUSE declaration in NDL and the file open attempt do not agree on the functional use of a station. For example, MYUSE = INPUT was specified in the NDL source program, but the application program attempted to open the file as an output file.

b. The current file open attempt would result in the opening of a file not declared in the NDL program.

c. FAMILY = DUMMY was specified in the FILE Section of the NDL program and no MCS is present in the Datacomm system.

The MCP causes a DS or DP condition (discontinue program) after the file open attempt is disapproved.

MESSAGE FLOW: MCS PRESENT BUT NOT PARTICIPATING

Figure 5.2 illustrates a data communication system that has a Message Control System present. The message flow is identical to the case illustrated by figure 5.1, except that the MCS is notified of several options from which a choice must be made.

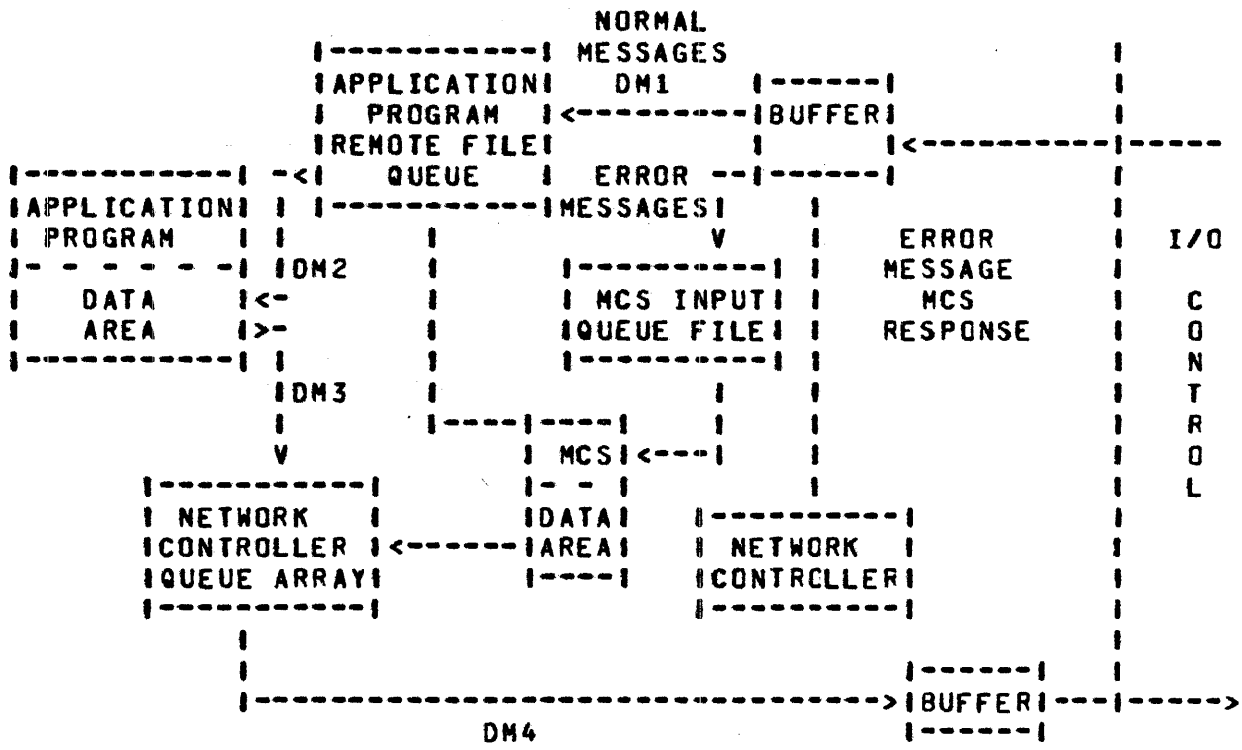

Figure 5.2. Datacomm Message Flow - MCS Not Participating

The MCS is notified of all file open and file close operations executed by the applicaton programs, and the MCS may approve or disapprove. Data communications errors are reported to the MCS by the Network Controller.

The MCS may communicate directly to an application program, but the application program cannot communicate directly to the MCS. The MCS is able to monitor and control system events that affect the application programs. The MCS may alter station/line priority, job priorities, or send special instructions to remote stations.

MESSAGE FLOW: MCS PRESENT AND PARTICIPATING

When the MCS is present and participating in the Datacomm network the message flow and data movement are considerably different from those shown in figure 5.2. Figure 5.3 illustrates the differences.

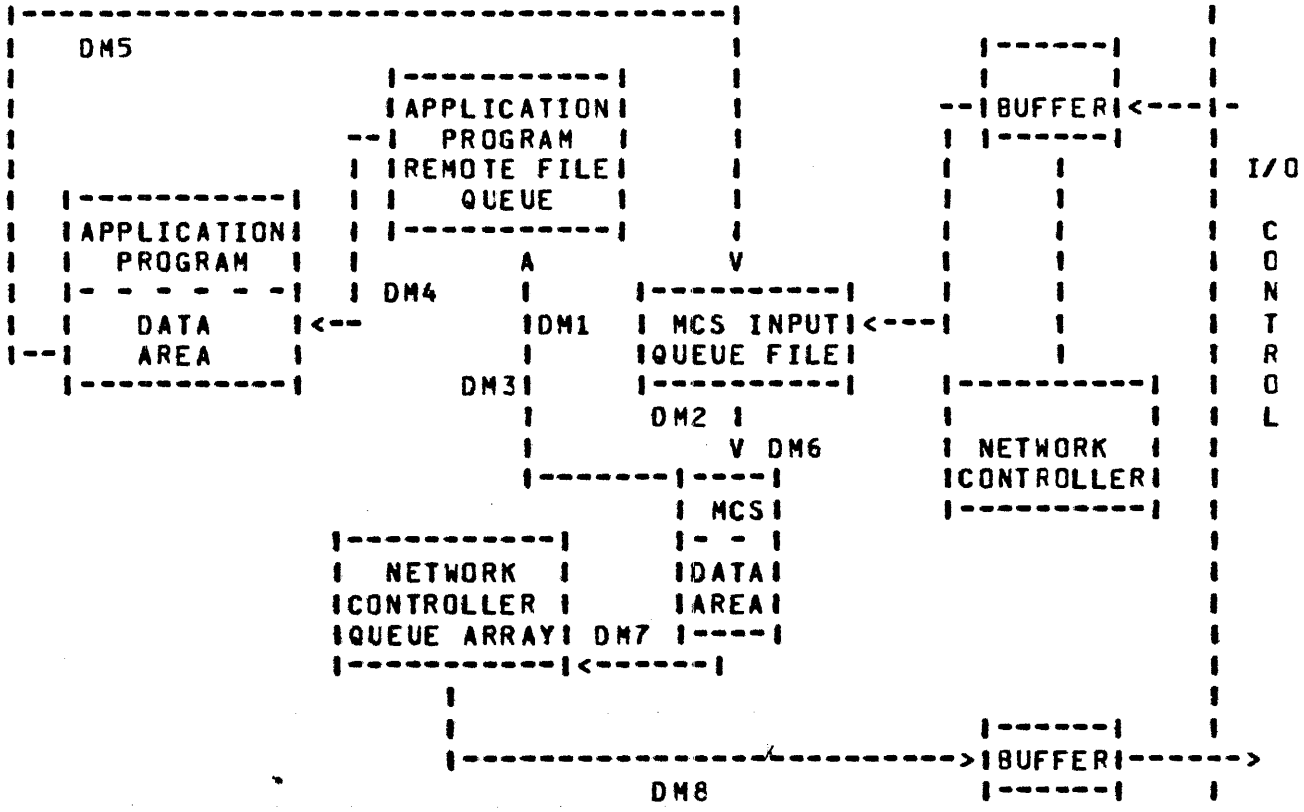

Figure 5.3. Datacomm Message Flow - MCS Participating

In the normal course of the MCS receiving a message from the remote network, processing the message, and sending a reply to the remote network, the following actions occur. Assume that the Network Controller, Message Control System, and application programs have been executed and are at Beginning of Job (BOJ).

a. The MCS does an OPEN on its remote file and the application program does an OPEN on its remote file.

b. The MCS executes a read operation on the remote file, which contains the file open request of the application program.

c. If the remote file was declared as DUMMY in the NDL program, the ATTACH MCS REQUEST attaches the stations if any. In the case of a normal remote file open request, the MCS can choose to approve or disapprove the entire file open.

d. The MCS does a read operation on the remote file and

the application program does a read operation on the remote file.

e. The message is transmitted from the I/O control to an input buffer.

f. The message is moved from the input buffer to the MCS remote file.

g. The MCS does a READ from its remote file. The first data movement is indicated by DM1 in figure 5.3.

h. By means of a remote file write, the MCS does a write operation to the remote file queue of the application program. This is shown by DM2 in figure 5.3. The MCS then performs the action specified in step d, and waits for the completion of a READ of its remote file.

i. Processing of the message is carried out by the application program.

j. The application program does a write operation on its remote file. DM4 shows the data movement. The application program performs the action specified in step d.

APPENDIX A. GLOSSARY

ACK

A control character that is used as an affirmative response to a normal selection (indicating "ready-to-receive") or a transmission (indicating "message accepted"). As an affirmative response to a selection, ACK may be preceded by station identification, AD1-AD2, or other information such as a reply.

ACK0, ACK1

These replies, when in proper sequence, indicate that the previous block received was accepted without error, and that the receiver is ready to accept the next block of the transmission. ACK0 is the positive response to selection (multipoint), or line bid (point-to-point). The alternate use of ACK0 and ACK1 is for affirmative replies. The use of ACK0 and ACK1 provides a sequential checking control for a series of replies. Thus, it is possible to maintain a continous check to ensure that each reply corresponds to the immediately preceding message block. The affirmative response to a poll is the transmission of a message. ACK0 is represented by a DLE character followed by a hexadecimal 3703. ACK1 is represented by a DLE character followed by a hexadecimal 3613.

AD1, AD2

A two-character address, established as the address of a terminal. These two characters are used to address a terminal in polling or selection, and used in the message header to identify the terminal from which a message is transmitted. This address may also be used as an identification prefix to acknowledge (ACK) that a terminal is ready to receive a message or to identify NAK. On receipt of a message, the receiving station may use AD1-AD2 to verify that the message originated at the polled terminal. For group addressing of broadcast to all terminals, AD1-AD2 indicates the terminal that will acknowledge receipt of the message. In systems which preclude "downstream" (terminal to terminal) communication, AD1-AD2 in the header, transmitted by the central computer, may be defined to represent the terminal address and is used for address checking.

ASCII (American Standard Code for Information Interchange)

This code, established by the American Standard Association, defines codes for a set of characters to be employed in the interchange of information between business equipment over telephone and telegraph circuits. The code consists of 128 control and graphic characters.

APPLICATION PROGRAM

A data processing program usually unique to one type of application.

AUTOMATIC CALLING UNIT (ACU)

A device that may be furnished by a communications carrier allowing a business machine to automatically establish a dialed link over the communications network.

AUTOPOLL

A facility provided by the firmware and hardware in the central computer which AUTOmatically POLLs any number of stations as specified in a character string called the "poll list" constructed by the data communications software.

It is considered "automatic" in that the data communications software is not required to initiate each station's poll and process the result. As long as no input messages are present at any station, the "autopoll" operation will continue.

BANDWIDTH

An expression of Hertz measurement which states the difference between the high and low frequencies in a communications channel.

BAUD

A unit of signaling speed equal to the number of conditions or signal events per second.

BAUDOT CODE

A code used in the transmission of data in which five bits represent one character. Named for Emile Baudot, a pioneer in printing telegraphy, it is sometimes referred to as five-bit code, five-unit code, or "teletype" code.

BINARY SYNCHRONOUS (BSC)

A method of data transmission which allows sending or receiving of data streams. The data streams may contain bit patterns which would normally be detected as control character sequences. Therefore, data streams containing object program code may be transmitted. The transmission is always synchronous.

BIT RATE

The speed, usually expressed in bits per second (BPS), with which bits are transmitted over a communication channel.

BIT SYNCHRONIZATION

The process by which the transmitting and receiving bit frequencies are made substantially the same and are maintained, by means of correction if necessary, in a desired phase relationship.

BLOCK

A group of characters or bits sent as an integral unit. Usually an error-checking procedure is applied over a block, for control and recovery purposes.

BLOCK CHECK CHARACTER (BCC)

The Block Check Character is a redundant character placed at the end of a transmission block for the purpose of error detection.

BLOCK NUMBER (BL#)

The block number consists of a two-character number identifying the sequential block number of a sub-divided message, each block being a separate I/O operation.

BROADCAST

The simultaneous sending of a message to several stations of a network.

BROADCAST SELECT (BSL)

The Broadcast Select control code informs all stations that "This is a broadcast message". In the broadcast sequence, AD1-AD2 identify the station which will acknowledge receipt of the message. Broadcast Select is followed immediately by a transmission block, without requiring acknowledgement of the selection.

CARRIER SYSTEM

A means of obtaining a number of channels over a single path by modulating each channel on a different carrier frequency and demodulating at the receiving point which restores the signals to their original form.

CENTRAL OFFICE

The place where a common carrier has equipment which interconnects customer transmission lines.

CENTRALIZED OPERATION

The control discipline used in a multipoint data communication network in which all message transfers must involve the control station. Transmissions directly between tributary stations are not allowed.

CHANNEL

The communication path used to transmit signals between two or more controlling devices such as the system and a data communications control.

CHARACTER SYNCHRONIZATION

A process in which the character frequencies of the transmitting and receiving ends of a transmission circuit are maintained in a phase relationship in order that the receiver can derive the transmitted characters from the signals received.

CIRCUIT

The configuration of equipment used to transmit data from one location to another. A circuit may involve more than one type of facility.

CIRCUIT ASSURANCE

The function of verifying the existence or the operational state of the communication channel between stations.

CODE

A system of symbols and rules for use in representing information.

COMMON CARRIER

A company that provides communication service for public hire.

COMMUNICATION LINK

The connection of two or more stations by the same communication channel. This link includes the communication control capability of the connected stations.

COMMUNICATION SYSTEM

The combination of all the links, link interface equipment, application and system software, including control procedures, that are required to effect the transmission of coded information between stations in the system.

CONDITIONING

Private and leased transmission lines can be conditioned to reduce distortion and thereby provide data transmission at lower error rates.

CONNECTION

The established path between two or more terminal installations. A permanent connection is established by using switching facilities.

CCITT (Consultative Committee International Telegraphic and Telephonic)

An international committee that defines telegraphic and telephone interconnections and switching standards.

CONTENTION (CON)

A functional character which instructs all receiving terminals to go to the contention mode. The contention mode is an operations condition on a data communication link where no station is designated as a master station. With contention mode, each station on the link must monitor the signals and wait for a quiescent condition before initiating a bid for master status.

CONTINUOUS OPERATION

A type of message transmission in which the master station need not stop for a reply, after transmitting each acknowledgement unit, but may continue transmission with the next acknowledgement unit.

CONTROL CHARACTER, DATA COMMUNICATIONS

A functional character intended to control or facilitate transmission of information over communication networks. The major communication control characters provided are: ACK, BEL, CAN, CR, DC1, DC2, DC3, DC4, DEL, DLE, ENQ, EOT, ESC, ETX, FIB, FF, FS, FSL, GS, GSL, HT, LF, NAK, NUL, POL, RS, SI, SO, SHO, STX, SYN, US, and VT.

CONTROL PROCEDURE, DATA COMMUNICATIONS

The means used to provide orderly communication of information between the stations on a data communications link.

CONTROL STATE

An operational state on a data communications link in which characters, other than communication controls, may be given control interpretations. A data link is in the control state when message transfer is not in progress.

CONTROL STATION

A permanently designated station on a data link (unaffected by link control procedures) with the overall responsibility for the orderly operation of the link. A control station generally has additional control capabilities (e.g., the capability to poll other stations) not provided at other stations, and is designated to initiate error recovery procedures, in the event of certain abnormal conditions on the link.

CONVERSATIONAL MODE

An operational mode in which message information is used in lieu of, or in addition to, control characters as replies for message information.

CYCLIC REDUNDANCY CHECK (CRC-16)

A 16-bit redundant character added to the end of a transmission block for the purpose of error detection and control. All characters following STX (or SOH) except SYN and the first DLE of a DLE DLE sequence are included in the CRC accumulation. A cyclic redundancy check is a division, performed by both the transmitting and receiving stations, using the numeric binary value of the message as a dividend, which is divided by a fixed polynomial. The most common polynomial used is X16 + X15 + Xn + 1. The quotient is discarded, and the remainder serves as the check character, which is then transmitted as the Block Check Character (BCC) immediately following a check-point character (ITB, ETB, or ETX). The receiving station compares the transmitted remainder to its own computed remainder, and finds no error if they are equal.

DATA COMMUNICATIONS SYSTEM

One or more data links, each of which may be operating in the same or a different mode.

DATA COMMUNICATIONS

The transfer of encoded information by means of electrical transmission systems.

DATA LINK

This is an ensemble of terminal installations, the interconnecting network, and controlling procedures operating in a particular mode, that permits information to be exchanged between locations.

DATA LINK ESCAPE (DLE)

Data Link Escape is a control character used to change the meaning of a limited number of contiguous characters that follow. They then become supplementary data transmission control functions. Only graphics and transmission control characters can be used in DLE sequences.

The Data Link Escape character combinations are used primarily for binary synchronous operation. The Data Link Escape character is always the first character of the two character combinations. The DLE combination characters are listed below:

ACK0 ACK1 RVI WACK	I I--- I I	These characters are used only for binary synchronous operation. Refer to the Glossary for a detailed description of each of these characters.
DLE STX	I---	This character is used to start transparent mode in BSC operation.
DLE DLE DLE EOT DLE ENQ DLE SYN	I I--- I I	Used as control characters during transparent mode of operation. The mnemonic for DLE EOT is DEOT.
DLE ETB DLE ETX DLE ITB	I I--- I	These characters are used to end transparent mode of operation.

DATA SET

A circuit termination device used to provide an interface between a data communication circuit and a data terminal. A modulation and/or demodulation function is typically performed in a data set.

DATA TERMINAL

The part of a station concerned with the functions of generating data and/or recording or displaying data, together with the control equipment, or system software needed to control these functions.

DEDICATED CHANNEL

A communication channel provided for the exclusive use of a specific subscriber on a contract basis. (See Private line.)

DELIMITER

A control character used to denote or limit the boundaries of a particular sequence of characters. The delimiter cannot be a member of the string.

DEMODULATION

The process of retrieving an original signal from a modulated carrier wave. This technique is used in data sets to make communication signals compatible with business machine signals (Contrast with definition of Modulation).

DEOI

The mnemonic for the DLE EOT communication control sequence, used to signal that the disconnect of a switched circuit must be initiated.

DIAL-UP

The use of a telephone to establish a station-to-station telephone contact.

DISCONNECT (DEOT)

A communication control sequence consisting of DLE followed by EOT, used to signal that a disconnect of a switched circuit must be initiated.

DISPLAY UNIT

A device which provides a visual representation of data (e.g., cathode-ray tube).

DUPLEX

In communications, pertains to the capability of simultaneous two-way transmission.

END OF TEST (EOT)

The End-of-Transmission control character is used to indicate the conclusion of a communication sequence. Receipt of an EOT will set the terminal in a control state, waiting for a polling, selection, or contention sequence. To insure that terminals are in a control state, EOT precedes a communication control sequence. EOT is transmitted by remote terminal as a "no traffic" response to a poll.

END OF TRANSMISSION BLOCK (ETB)

The End-of-Transmission Block control character is optionally used when messages are of sufficient length to warrant their being broken into smaller transmission blocks. ETB indicates the end of a block of data, either in a heading or in the message text. The heading or text is resumed after transmission of a block number and SOH or STX.

ENQUIRY (ENQ)

The Enquiry control chracter is used as a request for a response of station status or for a retransmission of control characters. This character is also used as the final character of a poll or in a selection when response from the other station is required.

ERROR

Any received character or sequence of characters that does not conform to those transmitted.

ERROR CONTROL

A system that detects the presence of errors. In some systems, refinements are added that correct some of the errors, either by operations on the received data, or by retransmission of the data from the source.

ERROR RECOVERY PROCEDURE

Data communications control procedures used to restore normal operations to a data link after unusual (abnormal) events have occurred.

EXCHANGE

A defined area where service is furnished by a communications carrier.

FACILITY

The type of communication medium used to provide communication circuits (e.g., cable, radio, open-wire).

FACSIMILE (FAX)

Transmission of pictures, maps, diagrams, etc. The image is scanned at the transfer, reconstructed at the receiving station, and duplicated on some form of paper.

FAMILY

A multistation file.

FAMILY POPULATION

The number of active stations in the family of the file. Family size is the number of stations assigned to the file.

FAST SELECT (FSL)

The Fast Select character is used in a selection sequence transmitted by the central computer. Fast Select is followed immediately by a transmission block, without requiring acknowledgement of the selection.

FILLER

A character used as a time-fill or space-fill when a block of a specified size is required and the heading and/or text characters are of insufficient length for the requirement.

FORMAT

The predetermined arrangement of characters, fields, lines, page numbers, punctuation marks, etc., used to clarify the presentation of data or a print-out. Refers to input, output and files.

FULL-DUPLEX CHANNEL

A communication channel where the signaling may be in both directions simultaneously. The signaling speeds used for the two directions of directions of transmission on a full-duplex channel need not be the same.

FULL-DUPLEX TRANSMISSION

A type of transmission where information is sent in both directions simultaneously.

GROUP SELECT (GSL)

This character is used to indicate "This is a message for a group of stations." In the group select sequence, AD1-AD2 identifies the station which will acknowledge receipt of the message. Group Select is followed immediately by a transmission block, without requiring acknowledgement of the selection.

HALF-DUPLEX CHANNEL

A communication channel where the signaling may be in either direction, but not in both directions at the same time.

HALF-DUPLEX TRANSMISSION

A type of transmission where information is sent either direction, but not in both directions simultaneously. (Refer to Two-way Alternate Transmission.)

HANDSHAKING

The exchange of control signals between data sets when the connection is established.

HEADER

A sequence of characters preceding the text of a message, which provides the information necessary to route the message to its ultimate destination(s). Headers may consist only of control information or may contain control information plus text. A message header is preceded by an SOH character and is ended by an STX character.

HERTZ (Hz)

A measure of frequency or bandwidth. The same as cycles per second.

HOLDING TIME

The length of time a communication channel is in use for each transmission. Includes both message time and operating time.

IDENTIFICATION

A sequence of characters used during the establishment of a connection and subsequently, if needed, to identify a station.

IDENTIFIER

A sequence of one or more characters transmitted by a station in order to uniquely identify itself.

INFORMATION BLOCK

A sequence of characters (fixed or variable length) which form a subdivision of an information message for the purpose of meeting transmission requirements.

INFORMATION MESSAGE

A sequence of characters conveying the text. It may also convey supplementary information to form a heading.

IN-PLANT SYSTEM

A data-handling system confined to one building or a number of buildings in one locality.

INTERMEDIATE TRANSMISSION BLOCK END (ITB)

The ITB control character is used for binary synchronous operations to divide a message (heading or text) for error-checking purposes, without causing a reversal of transmission direction. The block-check character immediately follows ITB and resets the block-check count. After the first intermediate block, successive intermediate blocks need not be preceded by STX or SOH. (For transparent data, which may contain control character sequences, each successive intermediate block must begin with DLE STX). If one intermediate block is heading and the next is heading and the next intermediate block is text, STX must begin the text block.

Normal line turnaround occurs after the last intermediate block, which is terminated by ETB or ETX (DLE ETB or DLE ETX for transparency). When one of these ending characters is received the receiving station responds to the entire transmission. If a block-check error is detected for any of the intermediate blocks, a negative reply is sent, requiring retransmission of all intermediate blocks.

All bisynchronous stations must have the ability to receive ITB and its attendant BCC. The ability to transmit the ITB character is a station option.

LINE ADAPTER

A line adapter consists of a logic card used to interface a data set or communications line with a Multi-Line or Single-Line I/O Control.

LINE SWITCHING

A switching technique that temporarily connects two lines so that two stations can directly exchange information.

LINK, DATA COMMUNICATION

The logical association of two or more stations interconnected by the same communication channel. A data link includes the communication control capability of the connected stations.

LOCAL CHANNEL

A channel connecting a communications subscriber to a central office.

MASTER STATION

A station temporarily designated (can be changed by the link control procedures) to have control of the data link at a given instant. Master status is normally conferred upon a station so that it may transmit a message.

MESSAGE

A sequence of characters arranged in a form suitable for the purpose of conveying information from an originator to one or more destinations (or addresses). It contains the information to be conveyed (called the text) and may, in addition, contain communication information to aid in the routing or handling of the message (called the HEADER).

MESSAGE CONTROL SYSTEM (MCS)

A Message Control System is an optional program that controls message flow between application programs and the Network Controller.

MESSAGE FORMAT

Rules for the placement of such portions of a message such as header, address, text, and end of message.

MESSAGE NUMBERING

The identification of each message within a communications system by the assignment of a sequential number.

MICROWAVE

All electromagnetic waves in the radio frequency spectrum above 890 megahertz.

MODEM

See definition of Data set.

MODULATION

The process by which some characteristic of one wave is varied in accordance with another wave. This technique is used in data sets to make business machine signals compatible with communication facilities (Contrast with definition of Demodulation).

MOST SIGNIFICANT BIT (MSB)

The most significant bit is that of a binary number which is assigned the greatest numerical value. It is generally assigned to the most significant bit position, as in the decimal numbering system.

MULTIDROP

See Multipoint network.

MULTI-LINE CONTROL (MLC)

The Multi-Line Control is an I/O control that provides the functional control between the computer system and the line adapters. It is an integral part of a multiline data communications subsystem.

MULTIPLE ADDRESS MESSAGE

A message to be delivered to more than one destination.

MULTIPLEXING

The division of a transmission facility into two or more channels.

MULTIPOINT CIRCUIT

A circuit interconnecting several stations (see definition of Multipoint Network).

MULTIPOINT NETWORK

1) A data communication line connecting three or more stations;

2) A data communication link with the control capability necessary to interconnect three or more stations.

NAK

The Negative Acknowledgement control character is used as a negative response to a normal selection (indicating not ready) or a transmission (indicating parity failure). Parity failure can occur for any character of a block or, in a message, for the BCC or block number sequence check. NAK may optionally be preceded by station identification AD1, AD2, or other information.

NETWORK

The ensemble of equipment through which connections are made between terminal installations. This equipment operates in real time and does not introduce, store, or forward delays. A switched telephone network is the network of telephone lines normally used for dialed telephone calls. A private network is a network of communication channels reserved for the use of one customer.

NETWORK CONTROLLER (NC)

The Network Controller interfaces with the Datacomm network hardware in order to assume responsibility for direct communication with the network.

NETWORK DEFINITION LANGUAGE (NDL)

A descriptive, free-form language for defining and implementing a data communications network. The NDL complier analyzes the input statements and generates a unique Network Controller.

NETWORK INFORMATION FILE (NIF)

A file containing tables that describe the physical and logical attributes of the network. The initialization values for the LINE, STATION, TERMINAL, and FILE tables of the Network Controller are contained in the NIF.

NON-CENTRALIZED OPERATION

A control discipline for multipoint data communication links. The transmissions may be between tributary stations or between the control station and a tributary station(s).

OFF-LINE

Used to describe terminal equipment not connected to a transmission line. Can also describe other devices not in direct communication with the central processing unit.

ON-LINE

Used to describe terminal equipment connected to a transmission line. Can also describe other devices in a direct communication with the central processing unit.

PAD CHARACTER (PAD)

All binary synchronous stations add a PAD character before and after each transmission to insure that the first and last characters are properly transmitted by the data set. The leading PAD character consists of a hexidecimal "2552" character SYN character, the trailing PAD character consists of all "1" bits (hexidecimal "2F-F2" character). Although the PAD character is comprised of eight bits, the receiver generally only checks the first four bit positions.

PARALLEL TRANSMISSION

The simultaneous transmission of a certain number of signal elements constituting the same telegraph or data signal. For example, all bits of a character may be sent simultaneously in parallel transmission. (Contrast with definition of Serial Transmission).

PARITY BIT

A bit associated with a character or block used to check for the presence of error within that character or block. This bit is chosen to make the Module 2 sum of the bits (including the parity bit), in the character or block, a zero (even) or a one (odd) as required by the system.

PARITY CHECK

A check that tests whether the number of ones (or zeros) in an array of binary digits is odd or even.

PASSIVE STATION

A station on a data link that (temporarily) is neither a master station nor a slave station.

POINT-TO-POINT CONNECTION

A configuration in which a connection is established between two, and only two, terminal installations. The connection may include switching facilities.

POLL (POL)

The character used to indicate "This is a poll," preceding ENQ in a polling sequence.

POLLING

A cyclical, sequential process, ordinarily software controlled, that checks specified points, e.g., remote terminals, for input. Polling is centrally controlled in order to maintain a strict discipline over the operation of a number of points. The reverse of polling is SELECTIVE CALLING (see below).

POLLING SUPERVISORY SEQUENCE

A supervisory sequence that performs a polling function.

PREFIX

A sequence of characters (other than communication controls) used in a supervisory sequence to define or qualify the meaning of that sequence.

PRIVATE LINE

A channel or circuit furnished a subscriber for his exclusive use (See definition of Dedicated Channel).

QUEUE

A linear list for which all insertions are usually made at one end of the list and all deletions and other accesses are made at the other end.

RECOVERY PROCEDURE

A process by which a responsible station within the network attempts to resolve either conflicting or erroneous conditions arising in the communicaton process. The control or master station is responsible for this procedure.

REDUNDANCY

A portion of the total message which can be eliminated without the loss of essential information.

REMOTE JOB ENTRY (RJE)

A computer communications system in which a central computer executes programs that were sent to it from terminal computers.

REVERSE CHANNEL

A communication channel between a slave station and a master station; used exclusively for control signals.

REVERSE INTERRUPT (RVI)

The reverse interrupt control character is used for binary synchronous operation. The RVI control sequence is a positive response used in place of the ACK0 or ACK1 positive acknowledgement. RVI is transmitted by a station which is in the process of receiving a message to request the sending station to terminate the current transmission for one of the following reasons:

1) The receiving station must transmit a high-priority message to the sending station.

2) The control station, when in a multipoint environment, acts as a receiver and wants to communicate with another station on the line. Successive Reverse Interrupt control characters cannot be transmitted, except in response to ENQ.

The sending station treats the RVI as a positive acknowledgement and responds by transmitting all data that prevents it from becoming a receiving station. More than one block transmission may be required to empty the buffers of the sending station.

The ability to receive RVI is mandatory for all binary synchronous stations, but the ability to transmit RVI is optional. RVI is represented by a DLE character followed by a hexadecimal "7C".

RECOMMENDED STANDARD 232C (RS232C)

This standard, provided by the Electronic Industries Association, is the recommended interface between data communications terminal equipment and data communications equipment using serial, binary data interchange.

SELECT (SEL)

The use of this character indicates "This is a normal select," when it precedes ENQ in a selection sequence.

SELECTION

A technique for assignment of slave status to a particular station on a Datacomm link.

SELECTION SUPERVISORY SEQUENCE

A supervisory sequence that performs a selection function.

SELECTIVE CALLING

The ability of a transmitting station to specify which station or stations on the same line are to receive a message.

SEQUENTIAL SELECT (SEQ)

The sequential select character is used to indicate that a group of remote terminals is being selected to receive a message addressed to that group. The last terminal selected in the group will acknowledge receipt of sequential select. Sequential select must be followed by AD1-AD2 of another terminal.

SERIAL TRANSMISSION

Transmission, at successive intervals, of the signal elements constituting the same telegraph or data signal. The sequential elements may be transmitted with or without interruption provided that they are not transmitted simultaneously. (Contrast with definition of Parallel transmission.)

SHUTDOWN TIME

The specific time when the Network Controller performs several functions necessary to the operation of the Datacomm network. The major functions are the emptying of all output queues, the disabling of any station input in progress, and the issuing of termination notification to all executing application programs or Message Control Systems. These functions must be performed before the Network Controller terminates itself.

SIGNAL-CONVERSION EQUIPMENT

That part of the terminal installation belonging to the data control channel, comprising at least one modulator or one demodulator. This equipment provides modulation according to the signals to be transmitted, and/or demodulation of the signals received.

SIMPLEX CHANNEL

A communication channel where the signaling may be in one direction only.

SINGLE-LINE CONTROL (SLC)

The Single-Line Control is an I/O control that provides the functional control between a computer system and a line adapter. The SLC is an integral part of a single-line data communications subsystem.

SINGLE-ADDRESS MESSAGE

A message to be delivered to only one destination.

SLAVE STATION

A station that has indicated its readiness to receive a message. The assignemnt of slave status is temporary and continues for the duration of a transmission.

START OF HEADER (SOH)

The Start-Of-Header control character is required only when a message header is to be sent with a transmission. When used, SOH is the first of a sequence of characters used for the message header. The header also may contain terminal identification AD1, AD2, and may, under definition for the specific application, contain other information pertinent to the transmission number (Xm#). A header is ended by STX (START OF TEXT).

START OF TEXT (STX)

The Start-OF-TEXT control character precedes a sequence of characters which form the text of the transmission. STX terminates a header.

START/STOP TRANSMISSION

Start/Stop transmission is an asynchronous transmission in which a group of code elements corresponding to a character signal is preceded by a start signal. The start signal prepares the receiving mechanism for the reception and registration of a character and is followed by a stop signal. The stop signal brings the receiving mechanism to rest in preparation for receiving the next character.

STATION

The aggregate of the terminal equipment (and software), and communication control equipment (and software) attached to a particular line adapter for the SLC or MLC. Used for the input or output of information for the communications system of which it is a part. For further discussion of "station" see DEFINITION OF THE TERM "STATION", Section 3.

STOP ELEMENT (IN A START/STOP SYSTEM)

Binary element that indicates to the terminal installation the completion of receipt of a character to bring the receiving mechanism to rest in preparation for receipt of the next character.

STORE-AND-FORWARD

Process of message handling used in a message-switching system.

STUNT BOX

A device to control the non-printing functions of a teleprinter terminal. Control characters can be sent to the stunt box over the communications channel.

SUPERVISORY SEQUENCE

A sequence of communication control and, possibly, non-communication control characters that perform a defined control function. A supervisory sequence consists of a prefix together with one or more control character delimiters.

SWITCHING

Operations involved in interconnecting circuits in order to establish a temporary communication channel between two or more stations.

SYNCHRONOUS IDLE (SYN)

The synchronous idle control character is used only by a synchronous transmission system, in the absence of any other character, to provide a signal for establishing and retaining a synchronism. On initiation of synchronous transmission, a number of SYN characters are transmitted prior to transmission of any other character to permit the receiving station to acquire character synchronization.

SYN is also used as a "time fill" when no other characters are available for transmission at any point in a character sequence except between ETB or ETX and the next following BCC. SYN is purged at the receiving terminal and is not included in the summation for BCC.

SYNCHRONOUS TRANSMISSION

A transmission process in which there is always an integral number of unit intervals between any two significant intervals.

TELEGRAPHY

A system of communication for the transmission of graphic symbols, usually letters or numerals, by use of a signal code.

TELEGRAPHY, PRINTING

A method of telegraph operation in which the received signals are automatically recorded in printed characters.

"TELEPRINTER"

Term used to refer to the equipment used in a printing telegraph system; a "teletypewriter".

TERMINAL

A terminal is defined as any device that can transmit or receive data through the communications lines of a Datacomm system (see also TERMINALS, Section 3, for further discussion).

TRANSPARENT MODE

An operational mode in which all coded combinations of eight-bit characters are allowed as message characters within a message text.

TRIBUTARY STATION

All stations, other than the control station, which are on a non-switched multipoint network are called tributary stations.

TURNAROUND TIME

The time required by data sets when switching between transmit and receive modes.

TWO-WAY SIMULTANEOUS TRANSMISSION

A type of transmission where information is sent in both directions simultaneously.

TWO-WAY ALTERNATE TRANSMISSION

A type of tranmission where information is sent in one direction or the other direction, but not both directions (see Half-duplex).

UNATTENDED OPERATION

The automatic features of a station's operation that permit the transmitting and receiving of messages without a computer operator being in attendance.

USASCII (UNITED STATES OF AMERICA STANDARD CODE FOR INFORMATION INTERCHANGE)

The USA standard code for information interchange. (See definition of ASCII.)

USER PROGRAMMING LANGUAGE (UPL)

A compiler-level language used primarily for writing Message Control Systems (MCS) for the B1800/B1700 Data Communications Systems.

VERTICAL REDUNDANCY CHECKING (VRC)

Vertical redundancy checking consists of generating an odd-parity as each character is received. This technique is used only in the ASCII normal mode (not with EBCDIC). The test is performed on every character, including the LRC.

VOICE-GRADE CHANNEL

A channel suitable for transmission of speech, digital, or analog data, or facsimile, generally with a frequency range of about 300 to 3000 Hertz.

WAIT-BEFORE TRANSMIT POSITIVE ACKNOWLEDGEMENT (WACK)

The WACK character (used only for binary synchronous operation) allows a receiving station to indicate a "temporarily-not-ready-to-receive" condition to the transmitting station. This character can be sent as a response to a text or heading block, selection sequence (multipoint), line bid (point-to-point with contention), or as an ID (identification) line bid sequence (switched network). WACK is a positive acknowledgement to the received data block or to selection.

The normal transmitting station response to WACK is ENQ, but EOT and DLE EOT are also valid responses. When ENQ is received, the station will continue. The ability to receive WACK is mandatory for all binary synchronous stations, but the capability is optional.

The WACK character is represented by a DLE character followed by a hexidecimal "37C3".

WIDEBAND CHANNEL

A channel wider in bandwidth than a voice-grade channel.

APPENDIX B. PROGRAM EXAMPLES

CUSTOMER INQUIRY

BURROUGHS B1800/B1700 COBOL COMPILER
INQUIRY

```
IDENTIFICATION DIVISION.
PROGRAM-ID. CUSTOMER INQUIRY.
REMARKS. THIS PROGRAM ALLOWS INQUIRY INTO THE CUSTOMER
    MASTER FILE BY RELATIVE RECORD NUMBER.
ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
SOURCE-COMPUTER. B-1700.
OBJECT-COMPUTER. B-1700.
INPUT-OUTPUT SECTION.
FILE CONTROL.
    SELECT CUSMAS ASSIGN TO DISK
        FILE-LIMIT IS 1 THRU 26
        ACCESS MODE IS RANDOM
        ACTUAL KEY IS RECORD-NUMBER.
    SELECT REMOTE1
        ASSIGN TO REMOTE
          ACTUAL KEY WS-KEY.
DATA DIVISION.
FILE SECTION.
FD REMOTE1
    FILE CONTAINS 2 STATIONS
      VALUE OF ID IS "REMOTE1".
01  AMT-MSG2   PC X(256).
01  RMT-MSG.
    03  RMT-TEXT          PIC X(2).
FD  CUSMAS
    FILE CONTAINS 5 BY 100 RECORDS
    VALUE OF ID IS "MASTER"/"FILE".
01  CUSTOMER-RECORD.
    02  FILLER PC X(31).
    02  CURBAL  PC S9(7)V99 USAGE CMP.
    02  DAYS30  PC S9(7)V99 USAGE CMP.
    02  DAYS60  PC S9(7)V99 USAGE CMP.
    02  DAYS90  PC S9(7)V99 USAGE CMP.
    02  FILLER  PC X(3).
    02  GRPYTD  PC S9(5) USAGE CMP.
    02  SLSYTD  PC S9(7) USAGE CMP.
```

```
    02  CUSMAN  PC X(24).
WORKING STORAGE-SECTION.
77  RECORD-NUMBER   PC  9(8)     CMP.
77  PAST-DUE        PC  9(8)V99  CMP.
77  RELREC          PC  99.
77  NO-OF-STATIONS PIC 99 VA 02.
01 START-HANDLER PIC X(15) VA "EX DEMO-HANDLER".
01 SEND-HANDLER-TO-EOJ PIC X(2)  VA "QC".
01  WS-KEY.
    03  FILLER  PIC 9.
    03  STAT-RSN  PIC  99  VA 1.
    03  TEST-LENGTH  PIC 9999.
    03  MESG-TYPE    PIC XXX.
01  FIRST-MSG.
    03  FILLER PIC 9(14) CMP VA a0C0000000000000a.
    03  FILLER PC X(22) VA "ENTER CUSTOMER NUMBER".
    03  FILLER PIC 9(12)  CMP VA a1F4040401E12a.
01  SECOND-MSG.
    03  FILLER  PC 9(14) CMP VA a0C0000000000000a.
    03  NAME    PC X(24).
    03  FILLER  PIC 9(6)  CMP VA a0D0000a.
    03  FILLER  PIC 9(6)  CMP VA a0D0000a.
    03  FILLER  PC X(16) VA "CURRENT BALANCE".
    03  BALCUR  PC Z,ZZZ,ZZZ9.99-.
    03  FILLER  PIC 9(6) CMP VA a0D0000a.
    03  FILLER  PC X(17)   VA "PAST DUE BALANCE".
    03  BALPST  PC Z,ZZZ,ZZ9.99-.
    03  FILLER  PIC 9(6) CMP VA a0D0000a.
    03  FILLER  PC X(10)   VA "YTD SALES".
    03  FILLER  PC X(10) VA SPACES.
    03  YTDSLS  PC Z,ZZZ,ZZ9-.
    03  FILLER  PIC 9(6)  CMP VA a0D0000a.
    03  FILLER  PIC X(11) VA "YTD PROFIT".
    03  FILLER  PC X(13) VA SPACES.
    03  YTDGRP  PC ZZZZ9-.
    03  FILLER  PIC 9(6) CMP VA a0D0000a.
    03  FILLER  PIC X(22) VA "ENTER CUSTOMER NUMBER".
    03  FILLER  PIC 9(12)  CMP VA a1F4040401E12a.
    03  FILLER  PIC 9(12)  CMP VA a0000000000000a.
PROCEDURE DIVISION.
DECLARATIVES.
ALL-USE SECTION.
    USE AFTER STANDARD ERROR PROCEDURE ON REMOTE1.
LABEL-1.
    DISPLAY "ERROR - RSN =" STAT-RSN.
    MOVE 1 TO SW1.
ALL-EXIT.
    EXIT.
END DECLARATIVES.
MAIN-LOOP SECTION.
```

```
           DUMMY-NAME.
               ZIP START-HANDLER.
               OPEN INPUT CUSMAS.
               OPEN I-O REMOTE1.
               IF NO-OF-STATIONS = 1 GO TO PARA1.
               PERFORM PARA1 VARYING STAT-RSN FROM 1 BY 1 UNTIL STAT-RSN
               GREATER THAN
               NO-OF-STATIONS.
               GO TO BIG-LOOP.
           PARA1.
               MOVE "000" TO MSG-TYPE.
               MOVE 35 TO TEST-LNGTH.
               WRITE AMT-MSG2 FROM FIRST-MSG.
           BIG-LOOP.
               READ REMOTE1 AT END GO TO END RTN.
               IF SW1 = 1 MOVE 0 TO SW1 GO TO BIG-LOOP.
               IF RMT-TEXT = "99" GO TO END-ONE.
               IF RMT-TEXT = "00" GO TO PARA1.
               MOVE RMT-TEXT TO RELREC.
               ADD 1 TO RELREC.
               MOVE RELREC TO RECORD-NUMBER.
               IF RELREC IS GREATER THAN 26 GO TO PARA1.
           READ-RTN.
               READ CUSMAS INVALID KEY GO TO ERROR-RTN.
           INITIALIZATION-RTN.
               ADD DAYS30 DAYS60 DAYS90 GIVING PAST DUE.
               MOVE CURBAL TO BALCUR.
               MOVE GRPYTD TO YTDGRP.
               MOVE SLSYTD TO YTDSLS.
               MOVE CUSNAM TO NAME.
               MOVE PAST-DUE TO BALPST.
WARNING..(252) RECEIVING FIELD TRUNCATION
               MOVE "000" TO MSG-TYPE.
               MOVE 203 TO TEST-LNGTH.
               WRITE AMT-MSG2 FROM SECOND-MSG.
               GO TO BIG-LOOP.
           ERROR-RTN.
               GO TO PARA1.
           END-ONE.
               ZIP SEND-HANDLER-TO-EOJ.
               GO TO BIG-LOOP.
           END-RTN.
               CLOSE REMOTE1.
               CLOSE CUSMAS.
               STOP RUN.
           END-OF-JOB.
```

```
C O D E   D I C T I O N A R Y
    BYTE LENGTH   CODEFILE RELATIVE DISK ADR
    ...........   ..........................
000 00000472      000010
001 00000070      000013
    00000542      TOTAL CODE


D A T A   D I C T I O N A R Y
    BYTE LENGTH   CODEFILE RELATIVE DISK ADR
    ...........   ..........................
000 00000927      000003


S - M A C H I N E   P A R A M E T E R S
              (S C R A T C H P A D)
LENB=9, SEGB=0, DISPB=11, COPXB=4, COPB=24, D.E.F=354, BDISPB=12
BASE RELATIVE ADDRESSES:
  DATA-SEGMENT-0=400, COP-TABLE=40, STACK=6413 (BIT LENGTH=1000)


P R O G R A M   P A R A M E T E R   B L O C K


FIRST-EXECUTE-INSTRUCTION=0,376
INTERPRETER-NAME=COBOL  /INTERP
STATIC-CORE=7416 BITS
DYNAMIC-CORE=0 BITS
DATA DICTIONARY STARTS AT CODEFILE SEGMENT 2,1 ENTRY
CODE DICTIONARY STARTS AT CODEFILE SEGMENT 9,2 ENTRIES
FILE PARAMETER BLOCKS START AT CODEFILE SEGMENT 14,2 ENTRIES


LAST ERROR AT SEQUENCE NUMBER     - 1 WARNING
::::: COMPILATION COMPLETE
ELAPSED TIME : 01 MINUTE, 15 SECONDS
PROGRAM REQUIRES 16 DISK SEGMENTS OF 180 BYTES EACH.
MEMORY REQUIREMENTS
  0000472 BYTES = LARGEST CODE SEGEMENT
  0000927 BYTES = BASE-TO-LIMIT AREA
  0000313 BYTES = DICTIONARIES AND RUN STRUCTURE
  0000689 BYTES = FILE BUFFERS & FILE INFO AREAS - INCLUDES 129
                  BYTES (+72 TO 540 IF DISK) FOR EACH FILE
  0002401 BYTES = ESTIMATED MEMORY REQUIRED TO RUN IF ALL FILES OPEN
132 SYMBOLIC RECORDS COMPILED AT 105.600 RECORDS PER MINUTE.
```

GAME

```
BURROUGHS B1800/B1700 COBOL COMPILER
NUMBER     /GAME
                IDENTIFICATION DIVISION.
                PROGRAM-ID. GAME.
                DATE-COMPILED.
                              TIME 07:56 DATE 10/16/74.
                ENVIRONMENT DIVISION.
                INPUT-OUTPUT SECTION.
                FILE-CONTROL.
                    SELECT TDFILE2 ASSIGN TO REMOTE.
                DATA DIVISION.
                FILE SECTION.
                FD  TDFILE2.
                01  R-RECORD.
                    03  INPUT-NO PC 999.
                    03  FILLER  PC X(253).
                WORKING-STORAGE SECTION.
                77 WAIT-NO PIC 9(5).
                77  WAIT-SCREEN  PIC 9 VA 0.
                01  NUMBERS.
                    03  INPUT-NUMBER PIC 999.
                    03  SECRET-NUMBER  PC 999.
                    03  LOW-NO   PC 9999.
                    03  HIGH-NO  PC 9999.
                01  SCREEN-1.
                    03  FILLER PIC 9(14) CMP VA @3C0000000000000@.
                    03  FILLER PIC X(21) VA "       NUMBERS GAME".
                    03  FILLER PIC 9(6) CMP VA @0D0000@.
                    03  FILLER PIC X(18) VA "             RANGE".
                    03  FILLER PIC 9(6) CMP VA @0D0000@.
                    03  FILLER PIC X(25) VA "       LOW          HIGH".
                    03  FILLER PIC 9(6) CMP VA @0D0000@.
                    03  FILLER PIC X(6) VA SPACES.
                    03  LOWVALUE PIC ZZZ9.
                    03   FILLER PC XXX VA SPACES.
                    03  FILLER PC 99 CMP VA @1F@.
                    03  MIDVALUE PC 999 VA SPACES.
                    03  FILLER PC 99 CMP VA @1F@.
                    03  FILLER PC XXX VA SPACES.
                    03 HIVALUE  PC Z(4) VA 1000.
                    03  FILLER PC X(36) VA SPACES.
                    03  FILLER PC 99 CMP VA @12@.
                    03  FILLER PIC 9(12) CMP VA @0000000000000@.
                    03  FILLER PIC 99 CMP VA @03@.
                01  SCREEN-2.
```

```
                03  FILLER PIC 9(14) CMP VA @0C0000000000000@.
                03  FILLER PC X(21) VA "         ************".
                03  FILLER PIC 9(6) CMP VA @0D0000@.
                03  FILLER PC X(23) VA "         *            ***".
                03  FILLER PIC 9(6) CMP VA @0D0000@.
                03  FILLER PC X(23) VA "         *            * *".
                03  FILLER PIC 9(6)  CMP VA @0D0000@.
                03  FILLER PC X(23) VA "         *            ***".
                03  FILLER PIC 9(6) CMP VA @0D0000@.
                03  FILLER PC X(19) VA "           *        *".
                03  FILLER PIC 9(6) CMP VA @0D0000@.
                03  FILLER PC X(18) VA "           *******".
                03  FILLER PIC 9(6) CMP VA @0D0000@.
                03  FILLER PC X(32) VA SPACES.
                03   FILLER PC X(32) VA "YOU LOSE?? BUY THE COFFEE".
                03  FILLER PIC 99 CMP VA @03@.
            01  CLEAR-SCREEN.
                03  FILLER PIC 9(20) CMP VA @0C00000000000000011030@.
            01  DUMMY-LINE.
                03  FILLER PIC 9(14) CMP VA @0C0000000000000@.
                03  FILLER PC 9999 CMP VA ZEROES.
                03  FILLER PC X(70) VA "**DUMMY** YOU WERE NOT IN
                      THE RANGE".
                03  FILLER PIC 99 CMP VA @03@.
            01  GOOD-BYE.
                03  FILLER PIC 9(14) CMP VA @0C0000000000000@.
                03  FILLER  PIC X(8) VA "GOOD-BYE".
                03  FILLER PIC 9(4) CMP VA @1103@.
            PROCEDURE DIVISION.
            DECLARATIVES.
            ALL-USE SECTION.
                USE AFTER STANDARD ERROR PROCEDURE ON TDFILE2.
            LABEL-1.
                MOVE 1 TO SW1.
            ALL-EXIT.
                EXIT.
            END DECLARATIVES.
            BEGIN.
                OPEN INPUT-OUTPUT TDFILE2.
            PLAY-GAME.
                MOVE ZEROES TO LOW-NO.
                MOVE 1000 TO HIGH-NO.
                MOVE TIME TO SECRET-NUMBER.
WARNING...(252) RECEIVED FIELD TRUNCATION
            DDISPLAY.
                MOVE LOW-NO TO LOWVALUE.
                MOVE HIGH-NO TO HIVALUE.
                WRITE R-RECORD FROM SCREEN-1.
            AGAIN.
                READ TDFILE2 AT END CLOSE TDFILE2 STOP RUN.
```

```
                    IF SW1 = 1 MOVE 0 TO SW1 GO TO AGAIN.
                    IF INPUT-NO = "BYE" GO TO END-JOB.
                    GO TO YOU-LOSE-2, WAIT-FOR-A-WHILE-LONGER,
                    DEPENDING ON WAIT-SCREEN.
                    MOVE INPUT-NO TO INPUT-NUMBER.
                    IF SECRET-NUMBER = INPUT-NUMBER
                        THEN YOU GO TO YOU-LOSE.
                    IF INPUT-NUMBER NOT > LOW-NO
                                OR INPUT-NUMBER NOT < HIGH-NO
                            GO TO WRITE-DUMMY.
                    IF SECRET-NUMBER < INPUT-NUMBER
                            MOVE INPUT-NUMBER TO HIGH-NO.
                    ELSE MOVE INPUT-NUMBER TO LOW-NO.
                WRITE-USUAL.
                    MOVE LOW-NO TO LOWVALUE.
                    MOVE HIGH-NO     TO HIVALUE.
                    WRITE R-RECORD FROM SCREEN-1.
                    GO TO AGAIN.
                YOU-LOSE.
                    WRITE R-RECORD FROM SCREEN-2.
                    MOVE 1 TO WAIT-SCREEN.
                    GO TO AGAIN.
                YOU-LOSE-2.
                    MOVE 0 TO WAIT-SCREEN.
                    WRITE R-RECORD FROM CLEAR-SCREEN.
                    GO TO PLAY-GAME.
                WRITE-DUMMY.
                    WRITE R-RECORD FROM DUMMY-LINE.
                    MOVE 2 TO WAIT-SCREEN.
                    GO TO AGAIN.
                WAIT-FOR-A-WHILE-LONGER.
                    MOVE 0 TO WAIT-SCREEN.
                WRITE R-RECORD FROM CLEAR-SCREEN.
                    GO TO DDISPLAY.
                END-JOB.
                    WRITE R-RECORD FROM GOOD-BYE.
                    STOP RUN.
                END-OF-JOB.
C  O  D  E     D  I  C  T  I  O  N  A  R  Y
   BYTE LENGTH   CODEFILE RELATIVE DISK ADR
   ...........   ........................
000 00000439     000010
    00000439     TOTAL CODE


D  A  T  A     D  I  C  T  I  O  N  A  R  Y
   BYTE LENGTH   CODEFILE RELATIVE DISK ADR
   ...........   ........................
000 00000998     000003
```

S - M A C H I N E P A R A M E T E R S
(S C R A T C H P A D)

LENB=9, SEGB=0, DISPB=11, COPXB=5, COPB=24, D.E.F.=354, EDISPB=12
BASE RELATIVE ADDRESSES:
  DATA-SEGMENT-0=472, COP-TABLE=40, STACK=6981 (BIT LENGTH=1000)

P R O G R A M P A R A M E T E R B L O C K

FIRST-EXECUTABLE-INSTRUCTION=0,51
INTERPRETER-NAME=COBOL /INTERP
STATIC-CORE=7984 BITS
DYNAMIC-CORE=0 BITS
DATA DICTIONARY STARTS AT CODEFILE SEGMENT 2, 1 ENTRY
CODE DICTIONARY STARTS AT CODEFILE SEGMENT 9, 1 ENTRY

LAST ERROR AT SEQUENCE NUMBER .1 WARNING
 ***** COMPILATION COMPLETE
ELASPED TIME : 01 MINUTE, 37 SECONDS
PROGRAM REQUIRES 14 DISK SEGMENTS OF 180 BYTES EACH.
MEMORY REQUIREMENTS
  0000439 BYTES = LARGEST CODE SEGMENT
  0000998 BYTES = BASE-TO-LIMIT AREA
  0000296 BYTES = DICTIONARIES AND RUN STRUCTURE
  0000402 BYTES = FILE BUFFERS & FILE INFO AREA - INCLUDES 129 BYTES
                  (+72 TO 540 IF DISK) FOR EACH FILE
  0002135 BYTES = ESTIMATED MEMORY REQUIRED TO RUN IF ALL FILES OPEN
129 SYMBOLIC RECORDS COMPILED AT 79,740 RECORDS PER MINUTE.

LIST OF FIGURES

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