Tandem NonStop (TM) and NonStop II (TM) Systems

EXPAND (TM) User's Manual

ABSTRACT: This manual describes the GUARDIAN/EXPAND operating system for network managers, programmers, and operators.

PRODUCT VERSION: EXPAND C00

OPERATING SYSTEM VERSION: GUARDIAN A06 (NonStop II System)
GUARDIAN E07 (NonStop System)

Throughout this document, all references to the "NonStop II system" indicate the software that runs on Tandem NonStop II processors and/or NonStop TXP (TM) processors.

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New editions incorporate all updates issued since the previous edition. Update packages, which are issued between editions, contain additional and replacement pages that you should merge into the most recent edition of the manual.

NEW AND CHANGED INFORMATION

This edition of the EXPAND User's Manual contains the following principal changes:

The new enhanced routing description is added. You may now declare, through a call to the system procedure SETMODE, a transmission priority. This transmission priority is used in combination with the type of transport media available to provide the most efficient transfer of data withing the network. The SETMODE function (71) is described in Section 3, System Procedures. Enhanced routing is described in Section 4.

A brief description of the CSS6100 Communications Management Interface (CMI) has been added to Section 4.

Two new sections have been added. These are:

Section 5. Fiber Optic Extension (FOX)
Section 6. Introduction to INFOSAT

Appendix A, File System Errors, has been removed. The File System errors are now listed in the GUARDIAN Operating System Programming Manual, Volume 2.

Appendix B, Console Messages, is now Appendix A.

Other minor changes resulting from comments submitted by users of this document have been incorporated into this edition.

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PREFACE

This manual describes the GUARDIAN/EXPAND operating system and applies to both Tandem NonStop Systems and Tandem NonStop II Systems. It assumes that you have basic knowledge of your system. The manual is organized into these sections:

Section 1.	Introduction to EXPAND.
Section 2.	Operator Interface: interactive functions such as editing remote files, copying files to a remote system, and running application programs on remote systems.
Section 3.	Programmer Interface: writing application programs that access remote files.
Section 4.	Network Management: security, the NETMON utility program, and considerations for SYSGEN, CUP, PUP, CMI, and XRAY.
Section 5.	Fiber Optic Extension (FOX): FOX network description, theory of operation, and considerations for use on a NonStop II system.
Section 6.	Introduction to INFOSAT: overview, description, and considerations for use of the computer/satellite network capabilities on a NonStop II system.
Appendix A.	Network-related console messages and brief explanation of file system errors for line error diagnosis.
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Each section assumes knowledge of the corresponding topic on a single system. You should know how to edit a file before attempting to edit a remote file; you should know how to write programs for a NonStop system before attempting to write programs for a network.

RELATED DOCUMENTATION

This manual is intended to be used in conjunction with other Tandem documentation--programming manuals, operating manuals, and so forth.

Additional information about interfacing to an X.25 packet switching network is in ACCESS, Volume 2: X.25 Access Methods (X25AM).

Additional information about performing line traces and obtaining line statistics is in AXCESS, Volume 1: Introduction and Communications Utility Program (CUP).

Additional information about system generation is in your System Management Manual.

Of these other manuals containing information applicable to EXPAND users, some apply only to Tandem NonStop System II computers, some apply only to original Tandem NonStop System computers, and some apply to both.

Part No.	Title
82000	System Description Manual (Tandem NonStop Systems)
82073	GUARDIAN Operating System Command Language and Utilities Manual
82075	System Operations Manual (Tandem NonStop II Systems)
82077	System Description Manual (Tandem NonStop II Systems)
82081	Transaction Application Language (TAL) Reference Manual
82082	ENVOY Byte-oriented Protocols Reference Manual
82083	ENSCRIBE Programming Manual
82084	AXCESS Data Communication Programming Manual
82089	System Operations Manual (Tandem NonStop Systems)
82311	Introduction to Tandem Data Communications
82333	AXCESS--Volume 1: Introduction and Communications Utility Program (CUP)
82334	AXCESS--Volume 2: X.25 Access Methods (X25AM)
82335	AXCESS--Volume 3: Device-specific Access Methods
82336	GUARDIAN Operating System Programming Manual--Volume 1
82337	GUARDIAN Operating System Programming Manual--Volume 2
82344	Communications Management Interface (CMI) Operator's Guide
82352	Guide to Software Manuals

SYNTAX CONVENTIONS IN THIS MANUAL

The following is a summary of the characters and symbols used in the syntax notation in this manual.

Notation	Meaning
UPPERCASE LETTERS	Represents keywords and reserved words.
lowercase letters	Represents variable entries supplied by the user.
Brackets []	Enclose optional syntax. Items enclosed in brackets represent a list of selections from which to choose one or none.
Braces {}	Enclose required syntax. Items enclosed in braces represent a list of selections from which to choose only one.
Vertical Bar |	Separates members of a horizontal list of selections.
Ellipsis ...	Follows a syntax that can be repeated any number of times.
Percent Sign %	Precedes a number in octal notation.

Punctuation and symbols other than described above must be entered precisely as shown.

SECTION 1

INTRODUCTION

The GUARDIAN/EXPAND operating system links together as many as 255 geographically distributed Tandem NonStop or NonStop II computer systems to create a network having the same reliability, capacity to preserve data base integrity, and potential for modular expansion as a single system.

DEFINITIONS

Before proceeding further, certain words used in this manual are defined:

- network

  In this manual, a network consists of two or more Tandem NonStop or NonStop II Systems connected by communication paths. The paths can be full-duplex phone lines, X.25 virtual circuits, fiber optic circuits, or satellite links. Each individual system, also called a node, runs under the GUARDIAN/EXPAND operating system.

- residence of files

  A disc file resides on a system if the file is located on a disc physically connected to that system; a device resides on a system if it is physically connected to that system; and a process resides on a system if it is running in a processor module of that system.

  Different partitions of a disc file can reside on different systems. (See "Alternate Key and Partitioned Files" in Section 3.

- local, remote, and network files

  With respect to any particular system, a local file is a file that resides on that system; a remote file is a file that resides on a different system; and a network file describes a file that can be either local or remote, when it is not necessary to make that distinction. The concepts of "local" and "remote" are relative to a particular system.

FEATURES OF EXPAND

Included among EXPAND features are:

- ease of operation and programming. EXPAND causes a network to appear to the user or programmer very much like a single system. Methods of accessing geographically remote devices, disc files and processes are identical to the corresponding procedures for accessing local files. If you know how to use the system, then you already know how to use a network of systems.

- pass-through routing. Systems need not be connected directly to one another to exchange data; in fact, messages may be passed through intermediate systems, allowing the number of communication lines in the network to be minimized.

- multi-line facility. A path can be made up of several lines where: a line is an actual physical communications wire and a path is the logical connection between two adjacent nodes in the EXPAND network. The multi-line facility increases network performance and reliability in the following manner:

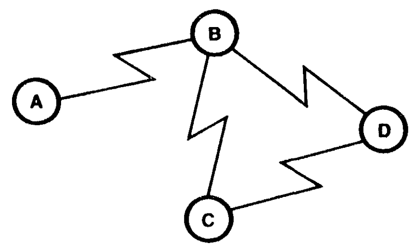
  - Increased network performance. Allows simultaneous transmission over all lines within a path; thus increasing the overall bandwidth of the path.

  - Increased network reliability. Because multiple lines may exist in a single path, a single line failure will not bring down a path. Because lines may be distributed between multiple controllers, a single controller failure will not bring down a path; however, all controllers in a path must be in the same controller group--see SYSGEN in the System Management Manual. In the event of either a single line or controller failure, the EXPAND error routine recovers messages in transit and reassigns the new path.

- best-path routing. When multiple paths between systems exist, EXPAND routes data via the best path. If the status of the currently used best path changes--for example, following the failure or recovery of a communication line--message traffic is automatically rerouted along the new best path.

- enhanced routing. EXPAND enhanced routing provides the optimal transfer of data within a network. You may define a transmission priority through a SETMODE function call. Then, once the best-path route is determined, the line handler uses this priority to order the message transmission on the path. Highest priority messages are transmitted first.

- modular expandability. Additional systems, up to 255, can be added to a network without disturbing existing systems.
- upward compatibility of existing application software. Application programs can be written in such a way that the network is transparent to them; existing programs require little or no modification to run on a network.
- X.25 compatibility. Any of the communication links between systems can be an X.25 public packet-switching network.
- fiber optic compatibility. The Fiber Optic Extension (FOX) network permits rapid data transfer between clusters within a ring of clusters connected by fiber optic links. The FOX network can be included as a portion of a larger GUARDIAN/ EXPAND network.
- satellite links. This feature provides for long distance transmission of large amounts of data over satellite channels instead of terrestrial lines. Satellite (INFOSAT) service can be provided anywhere within the continental United States of America.



- DATA EXCHANGED BETWEEN **A** and **C** IS "PASSED THROUGH" **B**.
- IF COMMUNICATION LINK **BC** SHOULD FAIL, MESSAGE TRAFFIC BETWEEN **A** AND **C** IS AUTOMATICALLY REROUTED ALONG PATH **ABDC**.

Figure 1-1. A Network of Systems

COMPONENTS OF EXPAND

EXPAND is an extension of the GUARDIAN operating system. Its components include the Network Control Process, the End-to-End Protocol, Network Line Handlers, and a Network Monitor Program.

Network Control Process (NCP) runs in each node of the network. The NCP functions include:

- establishing intersystem connections
- maintaining network-related system tables, including routing information
- determining the best path to other systems
- monitoring and logging changes in the status of the network and its constituent systems.

End-to-End protocol is a Tandem-defined, packet-switched protocol for the exchange of data between systems. The End-to-End protocol guarantees data integrity from sender to receiver regardless of how many intervening systems are involved in the transfer.

Four types of EXPAND network line handlers (Direct Connect, X.25, FOX, and Satellite Connect) manage a communication path and implement the End-to-End protocol.

- The Direct Connect line handler, which acts as an I/O process, manages one end of a full-duplex phone line between two systems.

Figure 1-2 shows a network consisting entirely of Direct Connect line handlers. The path between system A and C is a multi-line connection. The system not shown could have additional communication paths to other systems, which would be accessed by sending packets through system B. Each system has multiple line handlers, but only one NCP.

- the X.25 line handler provides the EXPAND link between systems connected through an X.25 network. The EXPAND X.25 line handler manages the X.25 "virtual circuit" running in an X.25 AXCESS process.

Figure 1-3 shows a system that connects to an X.25 network as well as to another system via EXPAND. Configuring such a system requires both EXPAND and AXCESS. The X.25 Access Process manages the physical communication line; the X.25 line handlers each manage one virtual circuit.

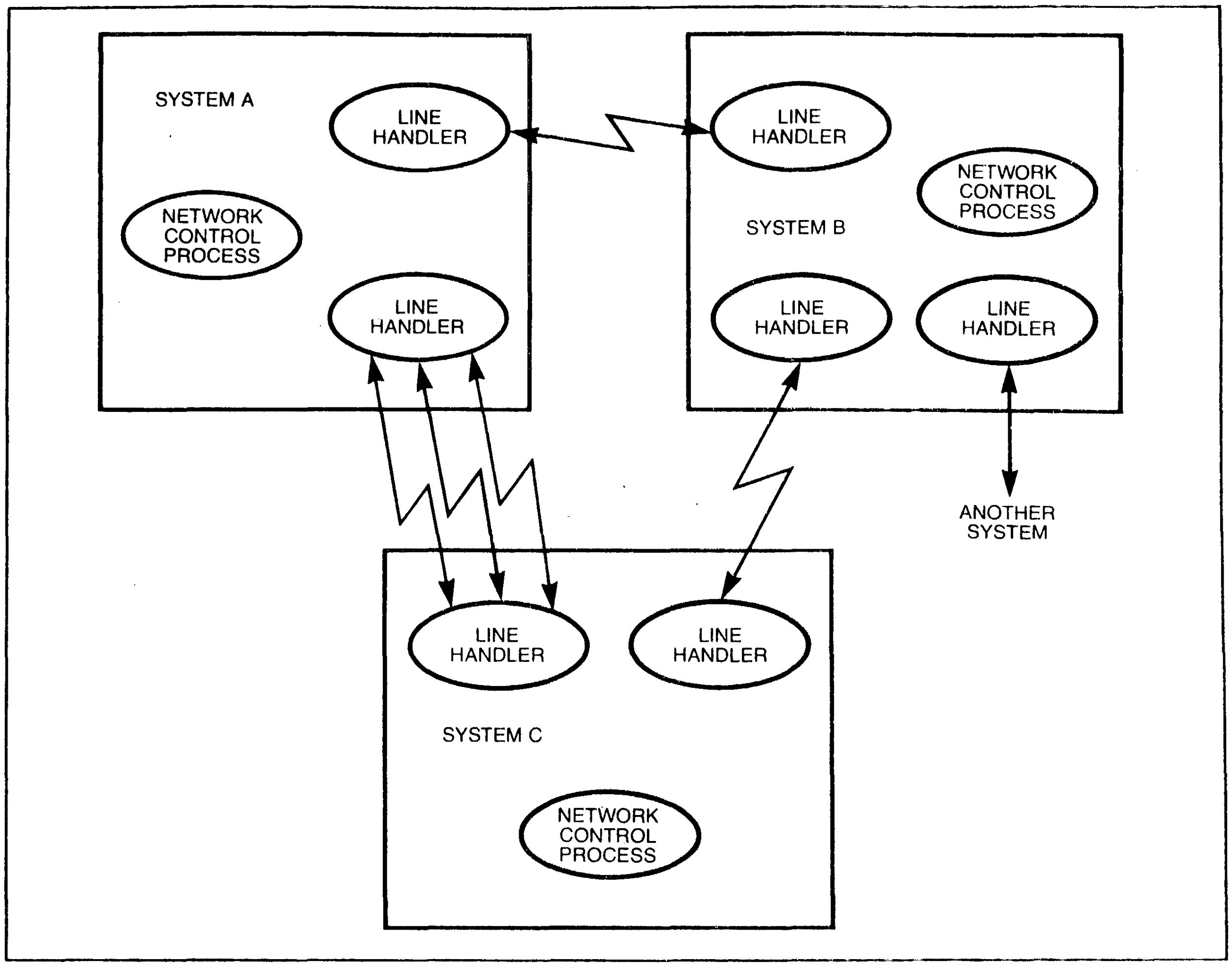


Figure 1-2. Network Containing Only Direct-Connect Line Handlers

The establishment of virtual circuits is controlled by the X.25 Access Process. The Communication Utility Program (CUP) provides the X.25 Access Process with the network address of the virtual circuits, and associates the virtual circuits with the correct line handler. Refer to AXCESS, Volume 1: Introduction and Communications Utility Program (CUP), and AXCESS, Volume 2: X.25 Access Methods (X25AM).

- The FOX network uses fiber optic links between clusters. FOX line handlers communicate directly over this interprocessor bus extension. Messages not requiring security checking usually bypass the line handlers and travel directly over the link from the sending process to the destination process.

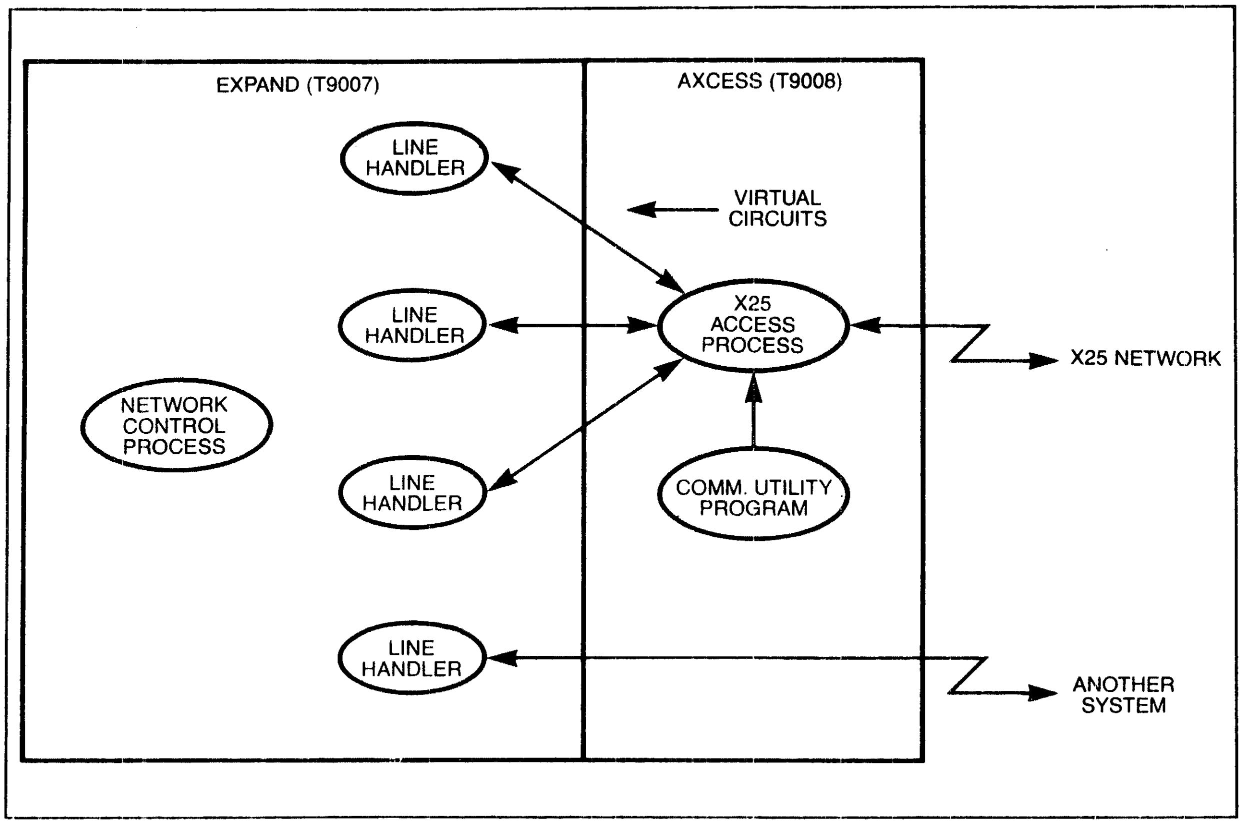


Figure 1-3. System with Direct-Connect and X.25 Line Handlers

The FOX line handlers also control the routing of packets for traffic being forwarded. That is, if a FOX cluster receives messages from a conventional EXPAND line handler that must be forwarded to another FOX cluster, the messages are passed through as in a conventional EXPAND environment--packet by packet.

Refer to Section 5 for a description of the Fiber Optic Extension (FOX) network.

- The Satellite Connect line handler manages one end of a satellite communications link between two systems. Messages are transmitted across satellite communication channels.

Section 6 contains information about the INFOSAT computer/ satellite network.

The Network Monitor (NETMON) utility program provides users, at any system, with the ability to monitor the current state of the network in terms of: number of systems connected, number of cpu's up on each system, line and path status, message traffic, etc.

SECTION 2

OPERATOR INTERFACE

This section describes the interface between an interactive user and a network; it assumes that you are familiar with the command interpreter and wish to perform similar operations on a remote system, such as:

- editing a remote file
- running a program on a remote system
- duplicating a set of files from one system to another

With a few exceptions, any operation performed on a system using the command interpreter can be performed on any system in a network.

NETWORK FILE ACCESS

Interactive interface to the system consists of using the command interpreter, FUP, PUP, the Editor, and other subsystems to access files. Access to a file is via its symbolic file name.

Access to a file in a network is achieved by qualifying a symbolic file name with the name of a system. For example, the command

```
:EDIT \NEWYORK.$SYSTEM.SYSTEM.TEXTFILE
```

edits the disc file $SYSTEM.SYSTEM.TEXTFILE, located on the system designated \NEWYORK. Similarly, the command

```
:RUN \PARIS.MYPROG
```

runs a program named MYPROG on the default volume and subvolume of the system designated \PARIS.

Thus, a network file name consists of a local file name preceded by a system name.

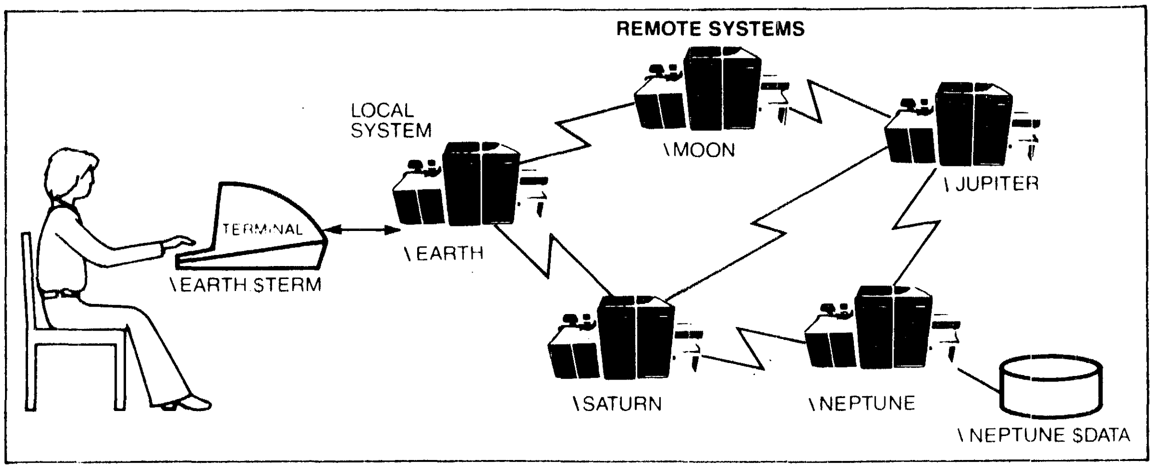


Figure 2-1. Interactive Network Access

System Names

Each system in a network is known by a system name. A system name consists of a backslash (\) followed by one to seven alphanumeric characters. The first character must be alphabetic. Examples of legal system names are:

```
\DETROIT
\SYS45
\XYX
```

A file residing on a system in a network is known by its system name, followed by the usual file name. Thus the disc file $MARKET.FRED.SALES, which resides on a disc drive connected to system \DETROIT, is named:

```
\DETROIT.$MARKET.FRED.SALES
```

Network File Names

Other forms of file names are extended to networks in the same manner.

EXAMPLES:

```
\DETROIT.$TAPE     ! a device name--in this case, a tape drive
                   ! residing on the system \DETROIT

\XYZ.$PROC         ! named process
```

The length restrictions on network file names are:

- Device names, including names of disc volumes, can have no more than six characters.
- Process names can have no more than four characters.

These restrictions are due to the inclusion of a system number in the internal form of file names.

A network file name has this form:

$$\text{\textbackslash system name.}\left\{\begin{array}{l}\text{network disc file name}\\ \text{network device name}\\ \text{network process name}\end{array}\right\}$$

where

system name

consists of one to seven alphanumeric characters, beginning with an alphabetic character.

network disc file name

is the same as the usual disc file name, except that the volume name is a dollar sign ($) followed by no more than six alphanumeric characters.

network device name

is a dollar sign ($) followed by no more than six alphanumeric characters.

network process name

is a dollar sign ($) followed by no more than four alphanumeric characters.

EXAMPLES:

Table 2-1 shows examples of valid and invalid network file names. In each case, the file name in the right-hand column would be legal for local access, but is too long for remote access. This does not prevent a system that belongs to a network from having a process named $SPOOL or a disc drive named $DISCVOL. However, such file names can only be accessed locally; they cannot be accessed by any remote process or user.

Table 2-1. Valid and Invalid Network File Names

Type of Name	Valid File Name	Invalid File Name
disc file	$SYSTEM.SYSTEM.TAL	$DISCVOL.SUB.YOURFILE
device	$LP	$PRINTER
process	$SPL	$SPOOL

Default System Name

Just as the VOLUME command specifies the default volume and subvolume names, the SYSTEM command designates a default system. The default system is implicitly appended to the front of every file name. The SYSTEM command has the form:

```
SYSTEM  [ system name ]

where

  system name

    designates the default system.  Omitting the system name
    designates, as the default, the system on which your
    command interpreter is running.
```

EXAMPLES:

```
   :SYSTEM \DETROIT
```

makes \DETROIT the default system and causes filenames to be expanded in the network format.

```
   :SYSTEM
```

removes any default system specification and causes filenames to be expanded in the local format.

Assuming that the local system is named \LOCAL and that the command interpreter is running on the local system then:

```
   :SYSTEM \LOCAL
   :STOP $ABCDE
```

would cause an "ILLEGAL FILE NAME" error, even though process $ABCDE happens to be running locally, because the SYSTEM \LOCAL command interprets $ABCDE as a network file name, subject to the four-character length restriction. However, the commands:

```
   :SYSTEM
   :STOP $ABCDE
```

would correctly interpret $ABCDE as a local process name and the STOP command would be executed.

Explicit and Implicit RUN Commands

To run programs on a network, you must keep in mind that the program file must reside on the system where the program is to run. The program file must also be secured for the appropriate network access; you as a user must have previously acquired network access rights to any systems on which you wish to run. Other than that, the explicit and implicit RUN commands work exactly as they do in a local system. For example, in the command:

```
   :SYSTEM
```

the local system is the default. The command

```
   :EDIT
```

runs the Editor on the local system. The command:

```
   :RUN MYPROG
```

runs MYPROG, which is stored on the default volume and subvolume, on the local system.

To run a program on the system \DETROIT, you would use the command:

```
:RUN \DETROIT.MYPROG
```

The default volume and subvolume names remain in effect; thus, the command interpreter runs a program file named MYPROG, assuming that this file exists on the remote system. Note however, that the local system remains the default. Thus, if MYPROG references any files internally, it will try to get them from \LOCAL.filenames unless another system is explicitly specified.

Implicit run commands work the same way. Just as the command:

```
:EDIT
```

implicitly runs a program whose object file is named $SYSTEM.SYSTEM.EDIT, the command:

```
:\DETROIT.EDIT
```

implicitly runs a program whose object file is named \DETROIT.$SYSTEM.SYSTEM.EDIT; because this file resides on system \DETROIT, and because programs run where their program files are located, the Editor runs on \DETROIT.

Running Programs Using the Default System Name

Some more illustrations of the use of the SYSTEM command in conjunction with RUN and implicit RUN commands may be useful. The command sequence:

```
:SYSTEM \XYZ
:EDIT YOURFILE
```

runs an Editor in system \XYZ. If the default volume and subvolume are both DEFLT, then the file being edited is \XYZ.DEFLT.DEFLT.YOURFILE. The command sequence:

```
:SYSTEM \DETROIT
:RUN MYPROG /IN \XYZ.$MKT.SUB.FNAME, OUT \SYS45.$SPL, CPU 3/
```

runs \DETROIT.DEFLT.DEFLT.MYPROG in processor 3 of system \DETROIT. The IN file is a disc file located on system \XYZ, and the OUT file is a process named $SPL running on system \SYS45.

THE WHO COMMAND

It is possible to forget what the default system is, and run a program remotely by mistake. You could type EDIT, for example, meaning to run the Editor in your own system, forgetting that you had previously issued a SYSTEM \DETROIT command.

The WHO command helps you remember where you are. Its syntax is simply:

```
  :WHO
```

The WHO command displays the name of the home terminal (the terminal on which your command interpreter is running), the name of the command interpreter, its primary and backup CPUs, and the current default names.

The WHO command display takes the following form:

```
  HOME TERMINAL: $TERM
  COMMAND INTERPRETER: \XYZ.$CI66  PRIMARY CPU: 03 BACKUP CPU: 01
  CURRENT VOLUME: $MKT.SUBVOL    CURRENT SYSTEM: \DETROIT
  USERID: 008,004   USERNAME: ADMIN.BILL    SECURITY: AAAA
```

If the SYSTEM command has not been used to specify a default system and naming conventions, then the "CURRENT SYSTEM" entry is omitted. Use the WHO command periodically to make sure you know where you are; in particular, use the WHO command before performing non-recoverable operations, such as purging files.

SUBSYSTEM CONSIDERATIONS

With certain exceptions, all Tandem subsystems accept file names in network form, allowing any operation to be executed on remote files.

This section lists the exceptional operations that cannot be performed remotely. Also listed here are special considerations to be kept in mind when operating subsystems in a network environment.

The absence of any particular subsystem from this list implies that all of its operations are valid in the network environment; a file name can be supplied in network form anywhere that the subsystem's command syntax allows a file name.

BACKUP and RESTORE

The BACKUP program must be run in the system where the disc files to be backed up reside. However, the tape file and list file for BACKUP can be anywhere in the network. Therefore, to back up a set of files on the system \REMOTE, use the commands:

```
:SYSTEM \REMOTE
:BACKUP / OUT \LOCAL.$LP / \LOCAL.$TAPE , $MYVOL.FILES.*
```

The same restriction applies to RESTORE.

COMINT

The commands RELOAD, XBUSUP, YBUSUP, XBUSDOWN, YBUSDOWN, SETTIME and TIME can apply only to the local system.

Normally, all LOGON, LOGOFF, and process-creation commands are sent to the CMON process running in the same system as the command interpreter. For systems in a network, however, process-creation commands are sent to the CMON process in the system where the new process is to run, allowing an installation to control remote process creation. LOGON and LOGOFF commands are still sent to the CMON process in the command interpreter's system.

EDIT

To reduce the amount of text that must be sent over the communication path, you should run the Editor on the same system as the text file to be edited. For example, with the Editor and its text file residing on different systems, the command:

```
*LIST "XYZ"
```

causes every line of text to be sent across the communication path. With the Editor and the text file on the same system, only the lines containing "XYZ" need be transmitted. If the text file is large, running the Editor in the same system as the text file causes a noticeable improvement in response time.

PUP

PUP commands can refer only to those devices residing on the system where PUP is running. Therefore, to list the free disc space on \REMOTE.$SYSTEM, the commands

```
:SYSTEM \REMOTE
:PUP LISTFREE $SYSTEM
```

must be issued; you cannot type

```
:PUP LISTFREE \REMOTE.$SYSTEM
```

The CONSOLE command can specify a remote device as the operator console as in the following example:

```
#CONSOLE \REMOTE.$LP
```

SYSGEN

The configuration file, list file, and work file can reside anywhere on the network. However, if the operating system image is to be placed directly onto disc (rather than tape, as is usually done) the disc volume specified must reside on the system where SYSGEN will run.

SPOOLER

The supervisor, collectors, and print processes belonging to a particular spooler must all run in the same system.

A spool system can include remote devices.

An application process can direct its output to a remote spooler, as with this command:

```
:RUN MYPROG/ OUT \CHICAGO.$SPL /
```

SECTION 3

PROGRAMMER INTERFACE

This section describes how to write application programs that access remote files. It covers these topics:

- overview of network programming
- network file names and conversion between internal and external file names
- network-related system procedures
- examples and considerations

It is assumed that the reader already knows how to program the Tandem NonStop or NonStop II System, and is familiar with concepts such as file names, CRTPIDS, and the use of the file system and process-control procedures. These subjects are discussed in your system programming manuals.

Writing a program that accesses remote files on a network is similar to writing an application that accesses only local files. A program need not be aware of whether the files it is accessing are local or remote unless it specifically needs to test for that condition.

A local program (or application) is understood to be a program that accesses files only on the system on which it is running. A network program is a program that has access to files on systems other than the one on which it is running. As usual, a file can be a disc file, a peripheral device, or another process.

A local application is written as if the network does not exist. If your application does not intend to access any remote files but is going to be run on a system that is part of a network, there are no special considerations.

SYSTEM NAMES AND SYSTEM NUMBERS

Each system in a network is assigned a unique name and number. The system name consists of a backslash (\) followed by one to seven alphanumeric characters. A system name qualifies a file name at the external (i.e., operator) level. For example, the system name \NEWYORK qualifies a file name passed as the IN parameter to a command interpreter RUN command:

```
  :TGAL/IN \NEWYORK.$SYSTEM.REPORT.TEXTFILE , OUT $LP/
```

Corresponding to the system name is the system number, an integer between 0 and 254 inclusive. The system number qualifies an internal file name.

The application process does not need to know about specific system names and numbers. The FNAMEEXPAND and FNAMECOLLAPSE procedures perform the conversions automatically.

To gain access to a file, a process passes the file's symbolic file name to the file system OPEN procedure, which returns a file number that can be passed to other file system procedures.

Remote files are accessed the same way. To specify a particular system as well as a file, a file name can optionally include a system number to identify the system. Such a file name is a network file name. A file name that does not include a system number is a local file name.

To access a file on its local system, a process can pass the name of the file in local form (which causes OPEN to assume that the local system is intended) or in network form, including the system number of the local system.

To access a file on a remote system, a process must pass a network file name, with the appropriate system number, to the OPEN procedure.

NETWORK FILE NAMES (INTERNAL FORM)

A file name in internal form (i.e., a 12-word array suitable for passing to the OPEN procedure) that is qualified by a system number is a network file name. Its form is:

```
network file name, INT:12,

where

  network file name [0].<0:7>

    is an ASCII backslash (\) (octal 134).

  network file name [0].<8:15>

    is a system number (in octal).

  network file name [1:3]

    is a device name or process ID.

  network file name [4:7]

    is a subvolume name or #qualifier.

  network file name [8:11]

    is a disc file name or subqualifier.
```

NOTE

> The device name or process identifier in words [1:3] does not include the initial dollar sign ($) normally associated with a device name or process identifier.

Because of the byte taken up by the system number, one less byte is available for the device name or process identifier. Therefore, the names of devices that can be accessed remotely consist of no more than six alphanumeric characters; names of processes that can be accessed remotely consist of no more than four alphanumeric characters. These restrictions are summarized in Table 3-1.

Table 3-1. Length Restrictions on Network File Names

Object Type Named	Local Name Limit	Network Name Limit
device (including disc volume)	$ and 7 characters	$ and 6 characters
process	$ and 5 characters	$ and 4 characters

Figure 3-1 shows two examples of network file names in internal form, assuming that \LA is system number 3.

```
a disc file:                                  a process:

    \LA.$SYSTEM.SUBVOL.DISCFILE                     \LA.$PROC
         ---------------                        ---------------
     0   |  \   |  %3  |                     0  |  \   |  %3  |
         |-------------|                        |-------------|
     1   |  S   |  Y   |                     1  |  P   |  R   |
         |-------------|                        |-------------|
     2   |  S   |  T   |                     2  |  O   |  C   |
         |-------------|                        |-------------|
     3   |  E   |  M   |                     3  | cpu  | pin  |
         |-------------|                        |-------------|
     4   |  S   |  U   |                     4  |      |      |
         |-------------|                        |-------------|
     5   |  B   |  V   |                     5  |      |      |
         |-------------|                        |-------------|
     6   |  O   |  L   |                     6  |      |      |
         |-------------|                        |-------------|
     7   |      |      |                     7  |      |      |
         |-------------|                        |-------------|
     8   |  D   |  I   |                     8  |      |      |
         |-------------|                        |-------------|
     9   |  S   |  C   |                     9  |      |      |
         |-------------|                        |-------------|
    10   |  F   |  I   |                    10  |      |      |
         |-------------|                        |-------------|
    11   |  L   |  E   |                    11  |      |      |
         ---------------                        ---------------
```

Figure 3-1. Network File Names in Internal Form

PROCESS IDs (CRTPIDs)

A process is uniquely identified by its process identifier. The network forms of process identifier are shown in the following paragraphs.

Timestamp Form

For the timestamp form, GUARDIAN assigns the process identifier when the process is created. The form of this type of process identifier is:

```
process id, INT:4,

where

  process id [0].<0:1>

    is 2.

  process id [0].<2:7>

    is unused.

  process id [0].<8:15>

    is the system number if the system is part of a network,
    or 0 otherwise.

  process id [1:2]

    is the low-order 32 bits of the creation timestamp, or 0
    for a system process.

  process id [3].<0:3>

    is unused.

  process id [3].<4:7>

    is the number of the CPU where the process is running.

  process id [3].<8:15>

    is the pin assigned by GUARDIAN to identify the process
    in the CPU.
```

Process-Name Form

The form of the process-name form of process identifier is:

```
process id, INT:4,

where

  process id [0].<0:7>

    is an ASCII backslash (\) (octal 134).

  process id [0].<8:15>

    is the system number (in octal).

  process id [1:2]

    is the process name.

  process id [3].<0:3>

    is blank-filled.

  process id [3].<4:7>

    is the CPU number.

  process id [3].<8:15>

    is the pin.
```

The process name, in words 1 and 2, can contain no more than four alphanumeric characters, the first of which must be alphabetic, and does not include the initial dollar sign ($) normally associated with a device name or process identifier.

CONVERSION BETWEEN EXTERNAL AND INTERNAL FILE NAMES

Two procedures, FNAMEEXPAND and FNAMECOLLAPSE, perform internal/external file name conversion. Another procedure, FNAMECOMPARE, compares names that may be in different forms.

FNAMEEXPAND converts a file name from external form to internal form, and expands partial file names using the default volume, subvolume and system. The conversion from external to internal form of a network file name includes changing the system name to the system number.

FNAMECOLLAPSE converts a file name from internal form to external form.

Both procedures convert local names to local names, and network names to network names.

The FNAMECOMPARE procedure compares two file names within a local or network environment to determine whether these file names refer to the same file or device. For example, one name can be a logical system name or a device number while the other reference is a symbolic name.

To be used in a TAL program, these procedures must be declared EXTERNAL. Like other system procedures, the external declarations can be specified with the compiler command:

```
?SOURCE $SYSTEM.SYSTEM.EXTDECS(FNAMEEXPAND,FNAMECOLLAPSE,
?                              FNAMECOMPARE)
```

FNAMECOLLAPSE Procedure

The FNAMECOLLAPSE procedure converts a file name from its internal to its external form. The system number of a network file name is converted to the corresponding system name.

The call to the FNAMECOLLAPSE procedure is:

```
{ CALL      }   FNAMECOLLAPSE ( internal name
{ length := }                 , external name )
```

where

length, INT

contains, on return, the number of bytes in the external name.

internal name, INT:ref:12

is the name to be converted. If this is in local form, it is converted to external local form; if it is in network form, it is converted to external network form.

external name, STRING:ref:26 or 34

contains, on return, the external form of the internal name. If the internal name is a local file name, the external name contains up to 26 bytes; if a network name is converted, the external name contains up to 34 bytes.

CONSIDERATIONS. It is the responsibility of the program calling FNAMECOLLAPSE to pass a valid file name in the internal name. Invalid file names cause unpredictable results.

If the internal name is in network form and the system number in the second byte does not correspond to any system in the network, FNAMECOLLAPSE supplies "???????" as the system name.

EXAMPLES:

This procedure would convert the local internal name:

```
$SYSTEM SUBVOL  MYFILE
```

to $SYSTEM.SUBVOL.MYFILE. Where system number 5 is named \SF, and we use <%5> to denote octal 5 in the second byte, the procedure would convert the network internal name:

```
  \<%5>SYSTEMSUBVOL  MYFILE
```

to the external form \SF.$SYSTEM.SUBVOL.MYFILE.

FNAMEEXPAND Procedure

The FNAMEEXPAND procedure expands a partial file name from the compacted external form to the standard 12-word internal form used by file system procedures.

The call to the FNAMEEXPAND procedure is:

```
{ CALL      }  FNAMEEXPAND ( external file name
{ length := }              , internal file name
                           , default names )
```

where

length, INT,

is the length in bytes of the file name in the external file name. If an invalid file name is specified, zero is returned.

external file name, STRING:ref:34

is the file name to be expanded. The file name must be in the form:

```
[\system name.]
  [$volume name.] [subvolume name.]
    disc file name    delimiter
    $device name    delimiter
    $logical device number    delimiter
```

where

delimiter

can be any character that would not be valid as part of an external file name, such as a comma, blank, or null character.

internal file name, INT:ref:12

is an array of 12 words where FNAMEEXPAND returns the expanded file name. This cannot be the same array as the external file name.

⟶

default names, INT:ref:8

is an array of eight words containing the default volume and subvolume names to be used in file name expansion, where:

default names [0:3]

is the default volume name, left-justified in the field.

default names [4:7]

is the default subvolume name, left-justified in the field.

default names [0:7] corresponds directly to word [1:8] of the command interpreter startup message. See your GUARDIAN programming manuals for the parameter message format.

FILE NAME EXPANSION BY FNAMEEXPAND. This procedure returns a disc file name in this form:

```
file name [0:3]  = $default volume name     blank fill
file name [4:7]  = default subvolume name   blank fill
file name [8:11] = disc file name           blank fill
```

It returns "subvolume name.disc file name" in this form:

```
file name [0:3]  = $default volume name     blank fill
file name [4:7]  = subvolume name           blank fill
file name [8:11] = disc file name           blank fill
```

It returns "$volume name.disc file name" in this form:

```
file name [0:3]  = $volume name             blank fill
file name [4:7]  = default subvolume name   blank fill
file name [8:11] = disc file name           blank fill
```

It returns "$volume name.subvolume name.disc file name" in this form:

```
file name [0:3]  = $volume name             blank fill
file name [4:7]  = subvolume name           blank fill
file name [8:11] = disc file name           blank fill
```

It returns a device name in this form:

```
  file name [0:11] = $device name             blank fill
```

It returns a logical device number in this form:

```
  file name [0:11] = $logical device number   blank fill
```

EXAMPLE:

Using these declarations:

```
  STRING .EXT^NAMES[0:24] := "  FILEA   $SYSTEM.FILEB  ",
         .P; ! string pointer.

  INT .INFILE[0:11],
      .OUTFILE[0:11],
      .DEFAULTS[0:7] := "$VOL1   ",
                        "SVOL1   ";
```

the FNAMEEXPAND procedure expands the external file names into a usable internal form:

```
      .
  SCAN EXT^NAMES WHILE " " -> @P; ! skip leading blanks.
  @P := FNAMEEXPAND(P, INFILE, DEFAULTS) + @P;
```

on the completion of FNAMEEXPAND, INFILE contains:

```
  "$VOL1   SVOL1   FILEA   "
```

which is suitable for passing to the file system CREATE, OPEN, RENAME, and PURGE procedures and to the process-control NEWPROCESS procedure.

P is incremented by the number of characters in the external file name.

```
      .
  SCAN P WHILE " " -> @P; ! skip intermediate blanks.
  CALL FNAMEEXPAND(P, OUTFILE, DEFAULTS);
      .
```

On the completion, OUTFILE contains:

```
  "$SYSTEM SVOL1   FILEB   ".
```

NETWORK CONSIDERATIONS. If the external file name includes a system name, FNAMEEXPAND converts the system name to the appropriate system number.

If the external file name does not include a system name, but a default system name is part of the DEFAULTS parameter, FNAMEEXPAND converts the external file name to a network internal file name having the correct system number.

NETWORK EXAMPLE:

Suppose that system \NEWYORK is assigned system number 4. Then the external file name \NEWYORK.$DATA.SUB.MYFILE is converted by FNAMEEXPAND to:

```
  "\<%4>DATA  SUB     MYFILE  "
```

where <%4> denotes octal 4 in the second byte.

If the system name does not exist in the network, FNAMEEXPAND supplies 255 as the system number.

FNAMECOMPARE Procedure

The FNAMECOMPARE procedure compares two file names within a local or network environment to determine whether these file names refer to the same file or device. For example, one name can be a logical system name or a device number while the other reference is a symbolic name. The file names compared must be in the standard 12-word internal format that is returned by FNAMEEXPAND.

The call to the FNAMECOMPARE procedure is:

```
{ CALL      }
{ status := }  FNAMECOMPARE ( file name 1, file name 2 )
```

where

status, INT,

is a value indicating the outcome of the comparison. Values for status are:

-1 =	(CCL), indicating that the file names do not refer to the same file.
0 =	(CCE), indicating that the file names refer to the same file.
+1 =	(CCG), indicating that the file names refer to the same volume name, device name, or process name on the same system; however, words [4:11] are not the same:

```
file name 1 [4] <> file name 2 [4] FOR 8.
```

A value less than negative one is the negative of a file system error code. This indicates that the comparison is not attempted due to this error condition. That value returned from the program function determines the condition code setting.

file name 1, INT:ref:12,

is the first file name for the comparison. Each file-name array can contain either a local file name or a network file name. Definitions of file names are in your GUARDIAN programming manuals.

⟶

file name 2, INT:ref:12,

is the second file name for the comparison.

CONSIDERATIONS. The arrays containing the file names for comparison are not modified.

Alphabetic characters within qualified process names are not upshifted before comparison.

If a logical device number format, such as $0076, is used for one file name, but not the other, the device table of the referenced system is consulted to determine whether the names are equivalent. This case is the only time the device table is used. All other comparisons involve only the examination of the two file names supplied.

Some of the most common negative file system error codes returned are:

-13 = an illegal file name specification for either file name is made.

-14 = the device does not exist. (See note.)

-18 = no such system is defined in this network. (See note.)

-22 = a parameter or buffer is out of bounds.

-250 = all paths to the system are down. (See note.)

NOTE

These negative file system error codes indicate that only one of the file names is passed in logical device number format (requiring a check of the device table) and the file name represents a device connected to a remote network node.

In a network node with a system number = 6, execution of the next code example returns a status of 0 and the condition code (CCE). In a non-network system, execution of this code returns a status of negative one and the condition code (CCL).

```
INT  .FNAME1[ 0:11 ],
     .FNAME2[ 0:11 ],
      STATUS;
```

```
FNAME1 ':=' ["$TERM1",9 * ["  "]];
FNAME2 ':=' [%56006,"TERM1 ",8 * ["  "]];   ! "\", 6, "TERM1"
STATUS := FNAMECOMPARE (FNAME1, FNAME2);
```

In any system, execution of the next code example returns a status of +1, and the condition code (CCG).

```
FNAME1 ':=' ["$SERVR  #START  UPDATING"];
FNAME2 ':=' ["$SERVR  #FINISH UPDATING"];
STATUS := FNAMECOMPARE (FNAME1, FNAME2);
```

In any system, execution of the next code example returns a status of zero and condition code (CCE). (The device name $DATAX is defined as logical device number 13 at SYSGEN time.)

```
FNAME1 ':=' ["$0013 ", 9 * ["  "]];
FNAME2 ':=' ["$DATAX", 9 * ["  "]];
STATUS := FNAMECOMPARE (FNAME1, FNAME2);
```

The FNAMECOMPARE procedure can also verify the specified file names as in the next code example:

```
! assume all variables and procedures have been
! properly defined and initialized elsewhere
!
! also assume  LITERAL  LEGAL = 0;

IF FNAMEEXPAND (EXTERNAL^NAME,INTERNAL^NAME,DEFAULT^NAMES) THEN
   BEGIN
   ! something reasonable was entered.
   IF FNAMECOMPARE (INTERNAL^NAME,INTERNAL^NAME) = LEGAL THEN
      ! it may not exist, but looks okay.
      BEGIN
        .
        ! normal processing.
        .
      END
   ELSE
      ! the format is not legal.
      BEGIN
        .
        ! error processing.
        .
      END;
   END;
```

EXAMPLE OF OPENING IN AND OUT FILES:

Consider this procedure, which reads a startup message, opens the IN file, and returns the file number of the IN file (for clarity, no error-checking is performed following calls to system procedures):

```
INT PROC OPEN^INFILE;
BEGIN
INT  .REC^BUF[0:32] := ["$RECEIVE",8 * ["  "]],
      REC^FNUM,
      IN^FNUM;

! open $RECEIVE, get startup message
CALL OPEN (REC^BUF, REC^FNUM);
CALL READ (REC^FNUM, REC^BUF,66)
CALL CLOSE (REC^FNUM);

! open the IN file
CALL OPEN (REC^BUF[9],IN^FNUM);
RETURN IN^FNUM;
END;
```

Any process that calls this procedure can communicate with its IN file without regard for the physical location of the file. Note that any existing program that reads its startup message and opens its IN and OUT files in this manner can handle network file names without modification or recompilation.

EXAMPLE OF NETWORK USE OF FNAMEEXPAND:

The next example demonstrates that the proper use of FNAMEEXPAND makes it unnecessary for an application program to be aware of the physical location of a file. The example procedure is called GET^FILENAME. It accepts a file name from a terminal and expands the file name using the defaults. The calling program passes to GET^FILENAME the file number of the terminal to be prompted and the current defaults obtained from the startup message. GET^FILENAME returns the expanded internal file name in the parameter FILENAME. GET^FILENAME returns the number of bytes in the external name read from the terminal, or 0 if the terminal input is not a legal file name.

The procedure keeps prompting the terminal until at least one nonblank character is input. For clarity, error detection and recovery are omitted.

```
  INT PROC GET^FILENAME(TERM^FNUM, DEFAULTS, FILENAME);
  INT  TERM^FNUM,    ! terminal file number
      .DEFAULTS,     ! default volume and subvolume
      .FILENAME;     ! internal file name goes here

  BEGIN
  INT  COUNT^READ,  ! number of characters read from terminal
      .BUF[0:39];   ! terminal buffer

  STRING .BUFS := @BUF '<<' 1,   ! string pointer to BUF
         .PTR;                   ! miscellaneous pointer

  WHILE 1 DO
    BEGIN
    ! Prompt terminal for input until at least
    !one character is read
    COUNT^READ := 0;
    WHILE NOT COUNT^READ DO
      BEGIN
      BUFS ':=' "ENTER FILE NAME:  ";
      CALL WRITEREAD (TERM^FNUM, BUF, 18, 80, COUNT^READ);
      IF <> THEN CALL ABEND;
      END;

    ! insert a scan stopper and FNAMEEXPAND delimiter
       BUFS[ COUNT^READ ] := 0;

       ! Scan off leading blanks
       @PTR := @BUFS;
       SCAN PTR WHILE " " -> @PTR;

       ! If at least one nonblank character was input, call
       ! FNAMEEXPAND and return; otherwise, loop back to the
       ! beginning.
       IF NOT $CARRY THEN
         RETURN  FNAMEEXPAND (PTR, FILENAME, DEFAULTS);
       END;  ! outer loop
     END;  ! proc GET^FILENAME
```

On return, FILENAME contains the expanded internal file name suitable for passing to the OPEN procedure. The physical location of the file is entirely transparent to the application program. From its point of view, the sequence of events surrounding the call to GET^FILENAME is:

1. Get the defaults from the startup message.

2. Open the terminal and pass the terminal file number, the defaults, and a 12-word FILENAME array to GET^FILENAME.

3. Pass the returned FILENAME to the OPEN procedure.

The calling program is unaware of whether the defaults, obtained from the startup message, are in local or network form.

FNAMEEXPAND returns a network file name in FILENAME if either:

- the external name, read from the terminal, included a system name, or

- the defaults included a system number.

However, the calling program passes FILENAME directly to OPEN without caring whether the file is local or remote.

SYSTEM PROCEDURES

The following summary lists the network-related system procedures by procedure name and function.

Procedure	Function
CONVERTPROCESSNAME	converts a process name from local to network form.
CREATEREMOTENAME	supplies a process name that is unique for a specified system in a network.
GETPPDENTRY	returns a particular entry in a specific system's Paired Process Directory (PPD).
GETREMOTECRTPID	returns the CRTPID, also known as the process ID, of a remote process whose CPU, PIN and system number are known.
GETSYSTEMNAME	supplies the system name associated with a system number, and returns the logical device number of the line handler controlling the path to a given system.
LOCATESYSTEM	provides the system number corresponding to a system name, and returns the logical device number of the line handler controlling the path to a given system.
MONITORNET	enables or disables receipt of system messages concerning the status of processors in remote systems.
MYSYSTEMNUMBER	provides a process with its own system number.
MYTERM	provides a process with the file name of its "home" terminal.
PROCESSINFO	supplies process status information.
REMOTEPROCESSORSTATUS	supplies the status of processor modules in a particular system in a network.
SETMODE 71 SETMODENOWAIT 71	defines the transmission priority for a particular file. Transmission priority is used by the line handler to determine the ordering of messages for transmission on a path.

Procedure	Function
VERIFYUSER	verifies, and optionally logs on, a user (described in Section 4 of this manual in the discussion of Programmatic Logon).

Like all other system procedures, these must be declared EXTERNAL to a TAL program before they can be used. Appropriate EXTERNAL declarations can be included in a program with the compiler command:

```
?SOURCE $SYSTEM.SYSTEM.EXTDECS( procedure name , ... )
```

CONVERTPROCESSNAME Procedure

The CONVERTPROCESSNAME procedure converts a process name from local to network form. The call to CONVERTPROCESSNAME is:

```
CALL CONVERTPROCESSNAME ( process name )


where

  process name, INT:ref:3,

    is a process name beginning with a dollar sign ($); on
    return, this buffer contains the internal network form of
    the process name:  a backslash (\) in the first byte, the
    calling process's system number in the second byte,
    followed by the process name.

    If the process name does not begin with "$", it is left
    unchanged.  If it contains more than four characters, the
    file system returns an error 20.
```

EXAMPLE:

An example of the action of CONVERTPROCESSNAME, assuming that MYSYSTEMNUMBER is 3:

```
  NAME ':=' "$PROC";
  CALL CONVERTPROCESSNAME( NAME );
```

On return from the call, "name" contains:

```
      --------------------
  0   |    \    |   %3   |
      |------------------|
  1   |    P    |   R    |
      |------------------|
  2   |    O    |   C    |
      --------------------
```

CREATEREMOTENAME Procedure

The CREATEREMOTENAME procedure supplies a process name that is unique for a specified system in a network. The call to CREATEREMOTENAME is:

```
CALL CREATEREMOTENAME( name, system number )


where

  name, INT:ref:3,

    returns a system-generated process name that is unique
    for the designated system.


  system number, INT:value,

    specifies the system for which the process name is to be
    created.
```

CONSIDERATIONS. These condition code settings result from use of the CREATEREMOTENAME procedure:

< (CCL) indicates that the remote PPD could not be accessed.

= (CCE) indicates that CREATEREMOTENAME was successful.

A third setting, > (CCG), is not returned.

CREATEREMOTENAME creates a process name in local form, consisting of "$Z" followed by three digits. A typical name would be "$Z123".

This name can be passed directly to the NEWPROCESS procedure to create a remote process having that name. It is unnecessary to append a system number to the process name, since the physical location of the program file determines where the new process will run. However, it is legal to append a system number, as long as the number matches the system number where the process is to be created.

The creation of a process name does not make an entry in the remote system's PPD.

EXAMPLE:

An example of the use of this procedure is:

```
  CALL CREATEREMOTENAME( NAME, SYS^NUM );
  IF < THEN ... ! problems
```

GETPPDENTRY Procedure

The GETPPDENTRY procedure returns a particular entry in a specific system's Paired Process Directory (PPD). The call to GETPPDENTRY is:

```
CALL GETPPDENTRY (entry number, system number, PPD entry)


where

  entry number, INT:value,

    specifies which PPD entry to return.  The first entry
    is 0, the second is 1, etc.


  system number, INT:value,

    specifies the system whose PPD is to be searched for the
    desired entry.


  PPD entry, INT:ref:9,

    returns the nine-word PPD entry specified by the given
    entry and system numbers, where:

      PPD entry [0:2]

        is the process name (in local form).


      PPD entry [3]

        is the CPU number and PIN of the primary process (CPU
        in high eight bits, PIN in low eight bits).


      PPD entry [4]

        is the CPU number and PIN of the backup process (CPU
        in high eight bits, PIN in low eight bits).


      PPD entry [5:8]

        is the process identifier of the ancestor, if any.
```

CONSIDERATIONS. These condition code settings result from use of the GETPPDENTRY procedure:

< (CCL)	indicates that the PPD in the given system could not be accessed.
= (CCE)	indicates that GETPPDENTRY completed successfully.
> (CCG)	indicates that there are no more entries in the PPD.

If the entry number is not currently being used, GETPPDENTRY returns CCE, and sets word 0 of PPD entry to 0. To check for that condition, an application could contain this code:

```
CALL GETPPDENTRY (ENTRY^NUM, SYS^NUM, PPD^ENTRY);
IF < THEN ... ; ! no more entries
IF = AND PPD^ENTRY THEN ... ! found an entry
ELSE ... ! try the next entry number
```

GETPPDENTRY is related to LOOKUPPROCESSNAME (described in your GUARDIAN programming manuals) in this manner:

> When you have the process name and want the PPD entry, use LOOKUPPROCESSNAME. When you want to pass the entry number, use GETPPDENTRY (use system number = MYSYSTEMNUMBER to access the local PPD).

EXAMPLE:

An application that needs to obtain all entries in the PPD of system 3 could use this code:

```
INT ENTRY^NUMBER := -1,
    SYSTEM^NUMBER := 3,
    DONE := 0,
   .PPD^ENTRY[0:8];
    .
    .
    .
DO
  BEGIN
  ENTRY^NUMBER := ENTRY^NUMBER + 1;
  CALL GETPPDENTRY (ENTRY^NUMBER, SYSTEM^NUMBER, PPD^ENTRY);
  IF = THEN ... ! do something with "PPD^ENTRY"
  ELSE DONE := 1;
  END
UNTIL DONE;
```

GETREMOTECRTPID Procedure

The GETREMOTECRTPID procedure returns the CRTPID, also known as the process identifier, of a process whose CPU, PIN and system number are known. The call to GETREMOTECRTPID is:

```
CALL GETREMOTECRTPID( pid, process id, system number )


where

  pid, INT:value,

    is the CPU number and PIN of the process whose process
    identifier is to be returned.


  process id, INT:ref:4,

    is an array of four words where GETREMOTECRTPID returns
    the process identifier of pid.  If the system number
    specifies a remote system, the process identifier is in
    network form; if the system number specifies the local
    system, the process identifier is in local form.  Both
    forms of process identifier are described in "Process IDs
    (CRTPIDs)", in this section.
```

CONSIDERATIONS. These condition code settings result from use of the GETREMOTECRTPID procedure:

< (CCL)	indicates that the GETCRTPID failed because no such process exists, the remote system could not be accessed, or the process has an inaccessible name comprising more than four characters.
= (CCE)	indicates that GETREMOTECRTPID was successful.

A third setting, > (CCG), is not returned.

EXAMPLE:

```
  CALL GETREMOTECRTPID (pid, crtpid, SYS^NUM);
  IF < THEN ... !  problems
```

GETSYSTEMNAME Procedure

The GETSYSTEMNAME procedure supplies the system name associated with a system number. The call to the GETSYSTEMNAME procedure is

```
{ CALL    }  GETSYSTEMNAME ( system number, system name )
{ ldev := }
```

where

ldev, INT,

is returned one of these values:

-1	indicates that all paths to the specified system are down
0	indicates that the system is not defined
+n	where n is a positive integer that indicates the logical device number of the line handler to the specified system.

system number, INT:value,

is the number of the system whose name is to be returned in system name, and will be between 0 and 254 inclusive.

system name, INT:ref:4,

contains, on return, the name corresponding to the system number.

CONSIDERATIONS. If the local system is not part of a network, then execution of the statement:

```
CALL GETSYSTEMNAME( MYSYSTEMNUMBER, NAME );
```

returns all blanks to NAME. (MYSYSTEMNUMBER provides a process with its own system number).

EXAMPLE:

```
LDEV := GETSYSTEMNAME (SYS^NUM, SYS^NAME);
IF LDEV <= 0 THEN ... ! error
```

LOCATESYSTEM Procedure

The LOCATESYSTEM procedure provides the system number corresponding to a system name, and returns the logical device number of the line handler controlling the path to a given system. The call to LOCATESYSTEM is:

```
{ CALL    }
{ ldev := }    LOCATESYSTEM (system number
                            , [system name])
```

where

ldev, INT,

is returned one of these values:

-1 indicates that all paths to the specified system are down

0 indicates that the system is not defined

+n where n is a positive integer that indicates the logical device number of the line handler to the specified system. In the case of multi-line, the LDEV returned is that of the path.

system number, INT:ref,

is the system number corresponding to the system name if the system name is provided. If the system name is not provided, the caller must provide the system number to be located.

system name, INT:ref:4,

if present, specifies the system to be located, and causes the corresponding system number to be returned as the system number.

EXAMPLES:

```
  ! locate \NEWYORK, and return its system number
  SYS^NAME ':=' \NEWYORK;
  LDEV := LOCATESYSTEM (SYS^NUM, SYS^NAME);
  IF  LDEV > 0  THEN ... ! success

  ! locate system 3
  SYS^NUM := 3;
  LDEV := LOCATESYSTEM (SYS^NUM);
  IF  LDEV <= 0  THEN ... ! problems
```

MONITORNET Procedure

The MONITORNET procedure enables or disables receipt of system messages concerning the status of processors in remote systems. The call to MONITORNET is:

```
CALL MONITORNET (enable)


where

  enable, INT,

    is either 1, to enable receipt of messages, or 0, to
    disable receipt of messages.
```

CONSIDERATIONS. A process that has enabled MONITORNET receives a system message via $RECEIVE whenever a change in the status of a remote processor occurs. The format of this message is:

```
word [0]         =  -8
word [1].<0:7>   =  system number
word [1].<8:15>  =  number of CPUs in the system
word [2]         =  current processor-status bit mask
word [3]         =  previous processor-status bit mask
```

The processor-status bit mask has, in the bit corresponding to the CPU number, a one to indicate that the processor is up, and a zero to indicate that the processor is down or does not exist.

MONITORNET provides notification of status changes for remote processors only. To receive notification of status changes for local processors, an application process still must call MONITORCPUS.

EXAMPLE:

```
CALL MONITORNET (1);
```

MYSYSTEMNUMBER Procedure

The MYSYSTEMNUMBER procedure provides a process with its own system number. The call to MYSYSTEMNUMBER is:

```
system number := MYSYSTEMNUMBER


where

  system number, INT,

    returns the caller's system number.
```

CONSIDERATIONS. If the caller is running in a system that is not part of a network, MYSYSTEMNUMBER returns 0. Since 0 is a legal system number, a process which has to determine whether the system it is running in is part of a network should contain the code:

```
  CALL GETSYSTEMNAME( MYSYSTEMNUMBER, name );
```

A return of all blanks in the name indicates that the system is not part of a network.

PROCESSINFO Procedure

The PROCESSINFO procedure returns process status information. The call to the PROCESSINFO procedure is:

```
{ CALL     }  PROCESSINFO (cpu-pin
{ error := }             , [ process id ]
                         , [ creator accessor id ]
                         , [ process accessor id ]
                         , [ priority ]
                         , [ program file name ]
                         , [ home terminal ]
                         , [ system number ]
                         , [ search mode ])
```

where

error, INT,

is returned one of these values to indicate the outcome of the call:

0 = status for process cpu-pin is returned.

1 = process cpu-pin does not exist. Status for next higher cpu-pin is returned. process id [3] = cpu-pin is the process for which status is returned.

2 = process cpu-pin does not exist and no higher cpu-pin exists.

3 = cpu is down.

4 = cpu does not exist.

5 = the system specified by system number could not be accessed.

99 = parameter error.

cpu-pin, INT:value,

specifies the process whose status is being requested, where:

cpu-pin.<0:7> is the cpu number.

cpu-pin.<8:15> is the pin number.

⟶

process id, INT:ref:4,

if present, is returned the process identifier of the process whose status is actually being returned. Note that this can be different from the process whose status was requested via cpu,pin (see error).

creator accessor id, INT:ref:1,

if present, returns the creator accessor identifier of the process identifier (see "Network Security", Section 4 for an explanation of the creator accessor identifier).

process accessor id, INT:ref:1,

if present, returns the process accessor identifier of the process identifier (see "Network Security", Section 4 for an explanation of the process accessor identifier).

priority, INT,

if present, returns the execution priority of this process.

program file name, INT:ref:12,

if present, returns the name of the process identifier's program file.

home terminal, INT:ref:12,

if present, returns the device name of the process identifier's home terminal. If the home terminal resides on the local system, home terminal is in local form (begins with a dollar sign ($); otherwise, home terminal is in network form (begins with a backslash (\)).

system number, INT:value,

if present, specifies the system (in a network) where the process for which information is to be returned is running. If this parameter is omitted, the local system is assumed.

⟶

search mode, INT:value,

if present, is a bit mask that specifies one or more "search" conditions. If omitted, zero is used.

CONSIDERATIONS. On the call, the parameters to PROCESSINFO contain the value(s) for the search condition(s) and the bit fields in search mode specify the conditions being searched for (1 = condition must be met; 0 = don't care):

search mode.<0>	indicates that the searched process must match process identifier for three words.
search mode.<1>	indicates that the searched process must match the creator accessor identifier.
search mode.<2>	indicates that the searched process must match the process accessor identifier.
search mode.<3>	indicates that the searched process must be equal to or less than priority.
search mode.<4>	indicates that the searched process must match program file name.
search mode.<5>	indicates that the searched process must match home terminal.

If multiple search conditions are specified, then all must be met.

If the system number specifies a remote system, the process identifier is returned in network form; otherwise, the process identifier is returned in local form.

If the process's home terminal is remote, home terminal is returned in network form; if the home terminal is local, home terminal is in local form.

EXAMPLE:

```
 ! return status for all processes run by me at my terminal.
 CAID := PROCESSACCESSID;
 CALL MYTERM (HOMETERM);
 PIN  := 0;
 MODE := %42000;
 WHILE PROCESSINFO (PIN, PID, CAID, PAID, PRI, PROG,
                    HOMETERM,, MODE) < 2 DO
   BEGIN
     .
     .
     .
     PIN := PID [3] + 1;
   END;
```

REMOTEPROCESSORSTATUS Procedure

The REMOTEPROCESSORSTATUS procedure supplies the status of processor modules in a particular system in a network. The call to REMOTEPROCESSORSTATUS is:

```
status := REMOTEPROCESSORSTATUS ( system number )


where

  status, INT(32),

    returns the processor status in this format: The
    high-order word contains the number of processors in the
    remote system. If the remote system is nonexistent or
    unavailable, the high-order word is 0.

    The low-order word contains a bit mask for processor
    availability. If the processor is up, the corresponding
    bit is 1; if the processor is down or nonexistent, the
    corresponding bit is 0.
```

CONSIDERATIONS. The system number for a particular system whose name is known can be obtained from the LOCATESYSTEM procedure.

The two words of status can be separated by "equivalencing" INT variables to the high and low-order words. For example, a TAL procedure that calls REMOTEPROCESSORSTATUS might contain these declarations:

```
INT(32) STATUS;
INT NUM^PROCESSORS = STATUS;          ! high-order word
INT BIT^MASK = NUM^PROCESSORS + 1;    ! low-order word
```

"Equivalenced" TAL variables are explained fully in the Transaction Application Language (TAL) Reference Manual.

The bits in the low-order word are ordered from 0 to 15, from left to right:

```
 0  1  2  3  4  5  6  7  8  9  10 11 12 13 14 15
-------------------------------------------------
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
-------------------------------------------------
```

REMOTEPROCESSORSTATUS can also be used to obtain the status of local processors, as shown here:

```
 INT(32) MY^PROCESSOR^STATUS;
 MY^PROCESSOR^STATUS := REMOTEPROCESSORSTATUS (MYSYSTEMNUMBER);
```

SETMODE Procedure
SETMODENOWAIT Procedure

SETMODE function code 71 (or SETMODENOWAIT function code 71) sets the priority to be used for the transmission of messages. The format is:

```
CALL SETMODE ( filenumber
             , 71
             , parameter-1
             , parameter-2
             , last-parameters )

CALL SETMODENOWAIT ( filenumber
                   , 71
                   , parameter-1
                   , parameter-2
                   , last-parameters )
```

where

filenumber, INT:value,

the file number returned by the call to OPEN.

71, INT:value,

set transmission priority function code.

parameter-1, INT:value,

0 (reserved).

parameter-2.0:7 = 0 (reserved)
parameter-2.8:15 = transmission priority field

the value for the transmission priority field (bits 8:15) may range from 0 through 255. A value of zero (the default) causes the CPU priority of the process to be used as the transmission priority. The value 1 is lowest priority. The value 255 is highest priority. Once a path is selected, the line handler processes highest priority messages first.

⟶

last-parameters, INT:ref:2

returns the previous setting of parameter-1 and parameter-2 for this function.

PROGRAMMING CONSIDERATIONS

This section presents considerations relating to network programming, including:

- network file names (external form)
- MYTERM procedure
- command interpreter startup message
- remote process creation
- saving file names
- key-sequenced and partitioned files

Network File Names (External Form)

An application program that handles file names in their external form needs to allocate 34 bytes to handle a fully qualified network file name, as shown in Figure 3-2.

```
\system name . $device or process . subvol . disc file name
|          |    /  \          |          |    |   |         |
1 +        7 +  1 + 1  +      6   +      1 +  8 + 1   +     8   =  34
```

Figure 3-2. Allocation of 34 Bytes for Network File Name

An example of a fully qualified network file name in external form is:

```
\NEWYORK.$ORDERS.PARTS.INVNTRY
```

MYTERM Procedure--Network Considerations

If the home terminal is local, MYTERM returns the name of the home terminal in local form; otherwise, MYTERM returns the name of the home terminal in network form.

Unlike the command interpreter startup message's IN and OUT files, the name returned by MYTERM is not affected by any SYSTEM command which the user may have issued. Therefore the command:

```
  :SYSTEM \SF
```

has no effect on MYTERM; if the home terminal is local, the home terminal name is in local form. However, this command would cause in IN and OUT files, even if they were local, to be passed to a process in network form.

Command Interpreter Startup Message

The first task performed by an application process is to open its $RECEIVE file and read the command interpreter startup message. This message supplies the application process with the names of its IN file, its OUT file, and the current defaults. (The startup message is described in your GUARDIAN programming manuals in the discussion of the command interpreter.)

IN AND OUT FILES. The names of the IN and OUT files are passed in local or network form, depending on whether each file is local or remote.

There is one exception to this rule: the name of a local file is passed in network form if the local system was explicitly specified (via the SYSTEM command) as the default system, and the file name was expanded using the default system. For example, suppose that the local system is \BUFFALO, and that these commands are issued:

```
  :SYSTEM \BUFFALO
  :RUN MYPROG /IN MYFILE/
```

Any SYSTEM system name command causes the command interpreter to expand all partial file names using the default system. Therefore, MYFILE is expanded by the command interpreter using the default system \BUFFALO, and the IN file passed to MYPROG is in network form.

An application process can either ignore or consider the physical location of its IN and OUT files. If the physical location of a file is not important, the process simply passes the file name to the OPEN procedure; if the physical location of the file is important, the process checks whether the first byte of the file name is a dollar sign or backslash ($ or \) and acts accordingly.

DEFAULTS. The name of the default system, if one has been explicitly defined, is passed as part of the default volume name. For example, following the command interpreter commands:

```
:VOLUME $VOL.SUBVOL
:SYSTEM \LONDON
```

assuming that \LONDON corresponds to system number 2, words [1:8] of the startup message sent to any process created by the command interpreter contain

```
\<2>VOL   SUBVOL
```

where <2> denotes octal (not ASCII) 2 in the second byte.

The default system is included in the default volume name only if a system has been explicitly specified via a SYSTEM system name command. The command

```
:SYSTEM
```

causes the default names to be passed in local form, as does the complete absence of a SYSTEM command.

Observe that the command:

```
:SYSTEM \BUFFALO
```

causes the default names to be passed in network form regardless of whether \BUFFALO is the local system.

Remote Process Creation

A process is created in a remote system the same way one is created in the local system: by passing the program file name to the NEWPROCESS procedure. There is one basic rule: a process's program file must reside on the system in which the process is to run.

If you want to create a remote process in a system that does not possess a copy of the program file, you must copy the program file to the remote system.

Assuming that the appropriate program file resides on the remote system, creating the remote process is accomplished by passing the program file name to the NEWPROCESS procedure. For example, this code runs TAL as an unnamed process on system \DETROIT, in CPU 2 at priority 140:

```
  STRING .PROC^NAME[0:27] := ["\DETROIT.$SYSTEM.SYSTEM.TAL", 0];
  INT  .PROGRAM^FILE[0:11],
       .PID,
        PRI := 140,
        CPU := 2,
        ERROR;
    .
    .
    .
  CALL FNAMEEXPAND (PROC^NAME, PROGRAM^FILE, DEFAULTS);
  CALL NEWPROCESS (PROGRAM^FILE, PRI, , CPU, PID, ERROR);
  IF ERROR THEN ...
```

CPU DEFAULTING. The CPU parameter of NEWPROCESS lets you specify the processor in which the new process is to run. Any remote processor can be used for process creation.

If the CPU parameter is not specified, the new process runs in a processor selected from among those processors specified at SYSGEN time as being available to the network.

SENDING THE STARTUP MESSAGE. After a process is created, it must be sent a startup message. When formatting the startup message, the creator must take care to convert the IN and OUT file names and the default names to network form, so the new process can reference its files correctly.

EXAMPLES:

Suppose that the creator wishes to designate itself as the new process's IN file. The creator could contain this code:

```
  ! first, get my process ID
  CALL GETCRTPID (MYPID, MYPROCESSID);
  ! convert to network form
  CALL CONVERTPROCESSNAME (MYPROCESSID);
  ! move into startup message
  STARTUP^MSG[9] ':=' MYPROCESSID FOR 4;
```

Note that if the creator is running as a named process, then CONVERTPROCESSNAME transforms the local name into network form. If the creator is running as an unnamed process, then its CRTPID already specifies the system number (in the second byte) and CONVERTPROCESSNAME leaves the CRTPID unaltered.

The code in the next example could be used to specify the creator's own OUT file as the new process's OUT file. Assume that OUTFILE contains the creator's OUT file name as obtained from its startup message.

```
  STRING .OUTFILES := @OUTFILE '<<' 1;
     .
     .
     .
  IF OUTFILES = "$" THEN ! change it to network form,
                         ! using my system number
    BEGIN
    OUTFILES[7] '=:' OUTFILES[6] FOR 7;
    OUTFILE := "\" '<<' 8  +  MYSYSTEMNUMBER;
    END;
```

If the first byte of OUTFILE contained a backslash (\) character (indicating a network file name), or neither a dollar sign ($) nor a backslash (indicating the CRTPID of an unnamed process), then OUTFILE would be left unchanged.

Similar code could ensure that the default names are passed correctly.

Other cases--for example, the new process's OUT file being specified as a process in some other system--must be handled on an individual basis. Keep in mind that the new process will assume that file names in local form are local files. If this would cause incorrect results, then the creator must modify the startup message before sending it.

Saving File Names

Programs that save network file names should save the file names in external form. File names in external form should be converted to internal form immediately before opening the file. The reason is that conversion from system name to system number depends on the current state of the communication path to the remote system: if the path is down, the system name is converted to system number 255, an illegal value that causes OPEN to fail.

Alternate-Key and Partitioned Files

An alternate-key file can be made to reside on a different system than the primary file by listing the alternate-key file's location in network form in the alternate key params array when the primary file is created, and passing the file name in network form to the CREATE procedure to create the alternate-key file. Passing a local file name to CREATE causes an alternate-key file to be created on the same system as the primary file, not on the default system.

Any file, including an alternate-key file, can be partitioned across system boundaries. To create a partitioned file having partitions on different systems, follow the same procedure used to create a partitioned file, as described in the ENSCRIBE Programming Manual. The partition params array is used in the same way. However, instead of supplying the $volume on which a partition is to reside, you must supply

```
  \system number   volume name
```

where the "$" is omitted from the volume name. Supplying a $volume name without a system number causes the partition to be created on the same system as the primary partition, not on the default system.

SECTION 4

NETWORK MANAGEMENT

This section presents information relevant to the management of a network. Topics included are:

- best-path determination
- enhanced routing
- Network Monitor (NETMON) utility program
- network security
- items to consider when using SYSGEN, CUP, PUP, CMI, and XRAY

BEST-PATH DETERMINATION

Intersystem messages are always sent via the best path between the two systems. The determination of the "best" path is made by assigning time factors based on line speed to the communication lines, and computing the sum of the time factors along each possible path.

The multi-line facility allows all lines in a path to be used simultaneously. The effective bandwidth will be the sum of the bandwidths of all lines in the path; that is, multiple packet messages are distributed over multiple lines.

If a line fails, the NCP updates its NETMAPS to reflect the decrease in path bandwidth. Reactivation of the line updates the NETMAPS to reflect the increase in bandwidth. If a controller fails, the NCP updates its NETMAPS to reflect the decrease in bandwidth for all lines connected to the failed controller.

Each line has a configured line time factor (SYSGEN LINESPEED), as shown in Table 4-1. The line handlers for the neighbor paths establish the time factor value during path initialization and whenever a line failure or activation occurs. For routing purposes, the neighbor NCPs agree to use the slower line speed (larger value). The following equation shows how the time factor for a multi-line path is determined:

$$\text{path TF} = \frac{\text{TF conversion factor}}{\dfrac{\text{TF conv fact}}{\text{line1 TF}} + \dfrac{\text{TF conv fact}}{\text{line2 TF}} + \ldots + \dfrac{\text{TF conv fact}}{\text{line n TF}}}$$

For example, the time factor for a multi-line path consisting of three lines with each line's speed configured for 4800 bps (bits per second) and time factor of 47 is:

$$\text{path TF} = \frac{224000}{\dfrac{224000}{47} + \dfrac{224000}{47} + \dfrac{224000}{47}}$$

$$= \frac{224000}{4765 + 4765 + 4765}$$

$$= \frac{224000}{14295} = 15.7 = 16$$

This results in converting the time factors to line speeds, adding the line speeds together to get a path speed, and then dividing the time factor conversion factor by the path speed to get the path time factor (number of seconds required to transmit 224000 bits).

Table 4-1. Time Factors According to Line Speed

Line Speed	Time Factor
2400 bps	93
4800 bps	47
9600 bps	23
19200 bps	12
50000 bps	5
56000 bps	4
224000 bps	1

The time factor represents the number of seconds it takes to transmit 224000 bits of data across a given line. For example, it takes 47 seconds to transmit 224000 bits across a 4800-bps line.

Consider this network:

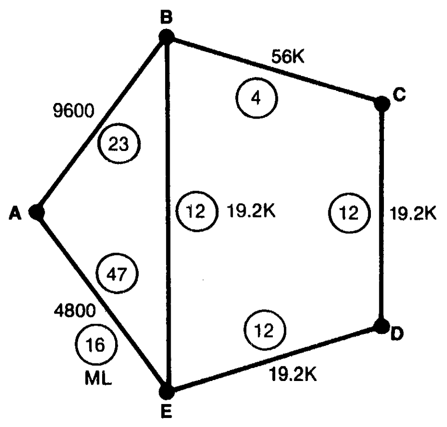


Figure 4-1. Time Factors Based on Line Speed

In Figure 4-1, a message from node A to node D (without multi-line) would be sent via the path A -> B -> C -> D. The total of the time factors along this path (23 + 4 + 12 = 39) is less than the total of the time factors along any other path. However, if a multi-line connection is made between node A and node E, by adding two 4800-bps lines, its time factor = 16.

Thus, with multi-line, a message from node A to node D takes the path A -> E -> D. The total time factor along this path is (16 + 12 = 28).

Each line's time factor is specified via SYSGEN. It is not necessary to use the values given in the table. If you want to force message traffic to travel over a slow path (for whatever reason), you can configure a small time factor for the line.

For the best-path routing scheme to work, each node must know about the current status of the network. The Network Control Process in each node maintains routing tables that enable messages to be routed correctly. Changes in the status of the network are propagated throughout the network by the exchange of messages between the NCPs in neighboring systems.

Suppose, in the example above, that the communication line between B and C fails:

> System C informs D of the failure; then D informs E, and E informs A and B.
>
> Meanwhile, B informs A and E, A informs E, and E informs A and D.

Each system updates its routing tables as it becomes aware of the change in network status, allowing all message traffic to be routed correctly. The same scheme of informing one's neighbor is used when a communication line becomes available or a new system is added to the network.

In the case of multi-line, the general network routing procedure remains the same with one exception. A line ready or not ready condition causes an update to the NETMAPS to reflect the change in the path time factor; however, a line down does not necessarily mean that the path is down (time factor of infinity). In fact, the new best path may indeed be the same as the original path.

The method of informing all nodes about routing changes is implemented in such a way that no system ever becomes confused about where to send a message; packets are always routed correctly regardless of any sequence of catastprophes.

ENHANCED ROUTING

EXPAND enhanced routing permits the network user to declare a transmission priority that is used in combination with the best available transmission path for optimal transfer of data over the best-path route selected.

Path Selection

The transmission modifiers LINESPEED and TRANSDELAY are available for defining EXPAND lines during system generation (SYSGEN):

LINESPEED. The LINESPEED modifier replaces the RSIZE modifier (RSIZE continues to be required--specification of LINESPEED overrides the RSIZE declaration). The value specified in the LINESPEED modifier sets the bandwidth (baud rate) of the communication line.

TRANSDELAY. The TRANSDELAY modifier set the amount of delay time expected during message transmission.

Transmission Priority

You specify a file's transmission priority by issuing a SETMODE file management request (see Section 3, System Procedures). EXPAND attempts to provide this priority by queuing the messages for transmission in the appropriate sequence.

The line handler uses the transmission priority to determine the ordering of messages for transmission on a path. That is, the line handler selects the highest priority message to present for transmission.

Transport Media

Each network node contains a Network Control Program (NCP) which exchanges information with each neighbor node regarding available routing alternatives.

Once you define (through SYSGEN) the bandwidth, the transmission delay, and the logical path grouping of lines (see the System Management Manual), the NCP reduces this data into a Network Routing Table (NRT) that resides in each processor at the node. For each destination system in the network, the NRT contains the logical device number (LDEV) of the "best-path" line handler based on bandwidth.

The GUARDIAN operating system uses the NRT to select the appropriate LDEV for message transmission to other nodes.

The line handler uses the transmission size--the message size at a given bandwidth (LINESPEED)--together with the amount of delay before the message can be dispatched (the amount of previously queued data at a given bandwidth), and the transmission delay (TRANSDELAY) value to select the best line for data transmission within a multi-line path.

NETMON Network Utility

The network monitor program NETMON lets one system within a network act as a center for monitoring the network. The NETMON program provides:

- logging of changes in network status
- logging of changes in processor status at remote systems
- a display of changes in processor status at remote systems
- a display of network traffic

The command to run NETMON is:

```
NETMON  [ /{run parameter},.../ ] [command]
```

where run parameter takes the form: IN command file, OUT list file, or NAME [$process name].

IN command file

specifies a disc file, terminal, or process where NETMON reads commands. NETMON reads 132-byte records from the command file until it encounters the end-of-file. Only one command is permitted per record. If this option is omitted, the home terminal is used.

OUT list file

specifies an existing disc file, terminal, or process where NETMON directs its listing output. If the command file is a terminal, the list file must be the same terminal. If this option is omitted, the home terminal is used.

NAME [$process name]

specifies a symbolic name to be assigned to the new process. This option is necessary if the BACKUPCPU command is issued. If the $process name is omitted, the operating system generates a name for the new process. If this option is omitted, the process is unnamed.

⟶

command

is one or more NETMON commands separated by semicolons. If a command is included, NETMON executes the command, then terminates. If the DISPLAY command is embedded in the command string, the DISPLAY command is terminated by the BREAK key. Any subsequent commands in the string are then executed before NETMON terminates.

EXAMPLES:

In this example, NETMON starts and prompts for commands:

```
:NETMON
NETWORK MONITOR - T9007E02 - (01JULY81)
>
```

In the next example, NETMON starts, executes a command to display the processor status of the systems in the network, sends the data to the printer $LP, and terminates:

```
:NETMON /OUT $LP/ CPUS
NETWORK MONITOR - T9007E02 - (01JULY81)
```

In the next example, NETMON starts and displays the network traffic and processor status for selected systems:

```
:NETMON /NAME/ BACKUPCPU3;ADD ALL;DISPLAY
NETWORK MONITOR - T9007E02 - (01JULY81)
```

NETMON then clears the screen and begins the display. The display continues until the BREAK key is pressed.

EXIT Command

The EXIT command terminates NETMON. Then, the command interpreter prompt appears. Control-Y also terminates NETMON.

FC (Fix Command)

The FC command lets you edit or repeat a command line. When this command executes, it displays the previous command line and prompts with a period. FC accepts three subcommands:

I inserts one or more characters

R replaces one or more characters

D deletes one or more characters.

FC again displays the command line after the line is edited, and prompts for another subcommand. FC terminates when it receives only a carriage return. The "COMINT" (command interpreter) section of the Operating System Command Language and Utilities Manual describes the FC command in detail.

EXAMPLE:

```
:NETMM
FILE ERROR 11
:fc
:NETMM
.    iO          (The I command inserts the O before the M)
:NETMOM
.     rN         (The R command replaces the M with an N)
:NETMON
.                (A carriage return terminates the FC command)
NETWORK MONITOR - T9007D05 - (01OCT80)
>
```

BREAK Key

When the BREAK key is pressed, the currently executing command aborts. The BREAK key also is the only way to terminate the DISPLAY command. If no command is executing, the command interpreter resumes control. The command interpreter's PAUSE command lets NETMON resume.

Control-Y

Control-Y terminates NETMON, then the command interpreter prompt appears. The EXIT command also terminates NETMON.

NETMON Commands

This subsection describes the commands that let you operate NETMON. These commands are summarized below and then described in detail.

ADD	adds one or more systems in the network to the display list.
BACKUPCPU	specifies the processor where the NETMON backup process is run.
CPUS	displays the status of the processors for all systems known by the specified system.
DELETE	deletes one or more systems in the network from the display list.
DISPLAY	shows the network traffic and processor status of the selected systems. Note that the only way to terminate Display mode is by using the BREAK key.
EXIT	terminates the NETMON program.
FC	(fix command) edits and reexecutes a command line.
HELP	provides command syntax for all NETMON commands.
LOGCENTRAL	starts or stops central logging at the local system. Note that only the System Manager designated SUPER.SUPER may use this command.
PATHS	displays the status of a selected path along with the status of lines within the path.
MAPS	displays the status of the network as seen from the selected system.
PERIOD	sets the sample interval time in seconds.
PROBE	displays the current paths from remote systems to the selected system.
SHOW	displays the systems selected with the ADD command.
STATS	displays detailed statistics for the selected system.
THRESHOLD	determines when to blink the rate of packets line in the display shown with the DISPLAY command.

ADD Command

The ADD command adds one or more systems to the list of systems to be displayed. The form of this command is:

```
ADD   { ALL                      }
      { system [, system,...]    }
```

where

ALL

specifies the first 16 systems in the network because only 16 systems fit on a screen for a display.

system

is specified either as a system name (e.g., \DALLAS) or a system number (e.g., 3).

EXAMPLE:

```
ADD \DALLAS,3,\WASH
```

BACKUPCPU Command

The BACKUPCPU command specifies the processor where the NETMON backup process is run. This command is useful when a terminal is constantly displaying network information; it is not useful when using NETMON interactively. Moreover, the NAME option must be included when NETMON is started. The form of the command is:

```
BACKUPCPU [cpu]


where

  cpu

    specifies the processor in which to run the backup NETMON
    process.  If this parameter is omitted, any existing
    backup NETMON process will be stopped.
```

EXAMPLE:

```
BACKUPCPU 3
```

CPUS Command

The CPUS command displays the status of the processors in all the systems that are known by the specified system. The NCP revision level also is displayed for each system. The form of the command is:

```
CPUS  [ system ]


where

  system

    is specified either as a system name (e.g., \DALLAS) or a
    system number (e.g., 3).  If this option is omitted, the
    local system is assumed.
```

The form of the display is:

```
  SYSTEM       0<--CPU STATES-->15   NCP LVL
sss system     nnnn,nnnn,nnnn,nnnn      x
sss(system)    nnnn,nnnn,nnnn,nnnn     --
sss system     nnnn,nnnn,nnnn,nnnn      x


where

  sss system

    is the number and name of one of the systems known to the
    selected system.  The selected system's name is enclosed
    in parentheses.


  nnnn,nnnn,nnnn,nnnn

    is the status of each processor in a system.  1 indicates
    the processor is active; 0 indicates it is inactive.  A
    period represents a nonexistent processor.  NOT CONNECTED
    means a known system is not attached to the network
    currently.
```

⟶

x

is the level of the network control process (NCP). The NCP level for the selected system is shown as a dash. This number is used by Tandem personnel.

EXAMPLE:

In this example, system 3, the selected system, has 12 processors that are all active. The system name \TS is enclosed in parentheses and the NCP level is a dash. System 11 has four processors, one of which is inactive. System 5 currently is not attached to the network.

```
>CPUS 3

   NETCPUS AT \TS (003)    #PATHS=06   TIME: 4 SEP 1980, 9:34:43

 SYSTEM       0<--CPU STATES-->15   NCP LVL
 2 \CUPRTNO  1111,....,....,....       1
 3(\TS     ) 1111,1111,1111,....      --
 4 \DALLAS   111.,....,....,....       1
 5 \CHICAGO  NOT CONNECTED
 6 \NEWYORK  111.,....,....,....       3
 7 \QA       1111,....,....,....       1
 8 \LA       11..,....,....,....       1
 9 \CORP     1111,1111,....,....       2
10 \MFG      1111,11..,....,....       1
11 \TORONTO  1110,....,....,....       4
```

DELETE Command

The DELETE command removes one or more systems from the list of systems to be displayed. The form of this command is:

```
DELETE    { ALL                     }
          { system [ ,system,...]   }

where

  ALL

    specifies all the systems that are currently selected.

  system

    is specified either as a system name (e.g., \DALLAS) or a
    system number (e.g., 3).
```

EXAMPLE:

```
  DELETE ALL
```

DISPLAY Command

The DISPLAY command starts the display mode of NETMON. This command is designed to function on a page-mode terminal; the display is unreadable on other devices. The display shows network traffic together with processor status for the systems specified via the ADD command. The initial values of the display are not shown until the first sample period has passed (see PERIOD command). The form of the DISPLAY command is:

```
DISPLAY
```

There are no options to specify.

NOTE

To stop display mode, press the BREAK key. This is the only means of exiting NETMON display mode.

Traffic data and processor status can be displayed for up to 16 systems. The format of this display is:

```
   \systemx(sss)      \systemx(sss)              \systemx(sss)
      tttt(pppp)         tttt(pppp)    . . .        tttt(pppp)
  avg uuuu(qqqq)     avg uuuu(qqqq)             avg uuuu(qqqq)
 ssssssssssssssss   ssssssssssssssss           ssssssssssssssss
```

where

\systemx(sss)

is the name (and number) of a system selected for status and traffic monitoring (see ADD command).

tttt

is the rate of packet transmission by the system during the sample period. This value is calculated from the number of packets transmitted during the sample period, adjusted to represent a packets-per-minute rate of transmission.

⟶

This value blinks off and on whenever the difference between the current traffic rate and the weighted average traffic rate (see uuuu(qqqq), below) reaches the threshold percentage (see THRESHOLD command).

pppp

is the rate of packet transmission for pass-through traffic during the sample period. This value is calculated from the number of packets transmitted during the sample period, adjusted to represent a packets-per-minute rate of transmission.

uuuu(qqqq)

represents the weighted averages for the network traffic rate. The weighted average is calculated from the preceding rate times a multiplier, plus the current rate, divided by an averaging divisor. uuuu is the weighted average traffic rate for the system during the sample period. (qqqq) is the weighted average traffic rate for pass-through traffic.

ssssssssssssssss

is the last reported processor status for the system. Each of the 16 positions shows a 1, 0, or hyphen. A 1 represents an active processor; a 0 represents an inactive processor; a hyphen represents a nonexistent processor. This line blinks off and on whenever a change in processor status is detected.

EXAMPLE:

This example of the network status display is abbreviated. The actual display would show four systems across and two systems down. In this example, \DALLAS is not currently connected to the network. Thus, it returns no statistics.

```
  >DISPLAY

                         NETWORK STATUS DISPLAY AT \TS (003)

         \SAA      (000)     \SAB       (001)     \CUPRTNO (002)
             2049(0000)            34(0000)            639(0062)
         avg 1215(0000)      avg   22(0000)      avg   474(0057)
        11---------------   0011-------------   11111-----------

         \TS       (003)     \DALLAS    (004)     \QA      (007)
              559(0004)                               1990(0661)
         avg  385(0003)                          avg  1008(0293)
        111111----------    000--------------   111-------------

        TIME: 28 APR 1981,  16:39:23
```

HELP Command

The HELP command lists the syntax or provides a brief description of the NETMON commands. The form of the command is:

```
HELP  [ALL    ]
      [command]

where

  ALL

    displays the syntax and describes all NETMON commands.
    This is the default.

  command

    specifies the command for which the syntax and
    description is displayed.
```

EXAMPLES:

```
>HELP

ADD  < system list >
BACKUPCPU  [ cpu # ]
CPUS  <system >
DELETE  < system list >
DISPLAY
EXIT
FC
HELP  [ < command name > | ALL ]
LOGCENTRAL  [ ON | OFF ]
MAPS  [ < system > ]
PATHS  [ < system > ], [PATH < pathnum > ]
PERIOD  [ < sample interval > ]
PROBE [< from system >], [PERIOD < interval >],
      [SYSTEM < to system >]
SHOW
STATS  [ < system > ]
THRESHOLD  [ < threshold > ]


>HELP MAPS

MAPS  [ < system > ]
  Displays NETMAPS for selected system.  Default local system.
```

LOGCENTRAL Command

The LOGCENTRAL command either starts or stops central logging of network messages on the local system. The form of this command is:

```
LOGCENTRAL   [OFF]
             [ON ]
```

where

OFF

stops central logging at the local system.

ON

starts central logging at the local system. If you specify neither ON nor OFF, the name of the system performing the central logging is displayed.

NOTE

Only the System Manager designated SUPER.SUPER is permitted to execute this command.

The network can create a lot of logging information if either a path or a system fails. Because the operator console usually is a slow printer, logging this information can tie up allocation of system resources at the receiving operator process. Disabling log messages at the local system, through PUP CONSOLE, ENABLE/DISABLE, reduces the amount of unnecessary traffic queued up at the operator process.

When central logging starts or stops or when the status of any network processor changes, a message is logged on all of the systems in the network. For example:

```
34  {...} NET:  LOGGING AT SYS sss
```

indicates that central logging was initiated

```
35  {...} NET:  LOCAL LOGGING RESUMED
```

indicates that central logging was terminated

```
48  {...} NET:  SYS sss  CPU STATUS ssssssssssssssss
```

indicates a change in processor status, where:

{...}	indicates the position for the date and time.
sss	is the system number.
ssssssssssssssss	is the last reported processor status for the specified system.

CONSIDERATIONS. If LOGCENTRAL is on, the NCP sends log messages to the logcentral system; however, no logging occurs to the local operator process (disc-resident operator log). On the other hand, if the path to the logcentral system is down, the messages are logged to the local operator process.

MAPS Command

The MAPS command displays the status of the network as seen from the selected system. This command provides the ability to look at the network from any system even though NETMON is running elsewhere. The form of the command is:

```
MAPS [ system ]


where

  system

    is either a system name or a system number.  If this
    option is omitted, the local system is assumed.
```

This command displays as many as six paths per line on devices with fewer than 132 columns and as many as ten paths per line on devices with 132 or more columns. If the selected system has more paths than will fit on one line of the output device, the additional paths are shown on the next line and a blank line is inserted between systems. The form of the display is:

```
NETWORK MONITOR - T9007D05 - (01OCT80)

    NETMAPS AT <system>(sss) #PATHS=<nn>   TIME: <date>,<time>

  SYSTEM                    TIME (DISTANCE) BY PATH
sss <systema> ttttt(dd)  ttttt(dd)* ttttt(dd)  . . .  ttttt(dd)
sss <systemb> ttttt(dd)  ttttt(dd)* ttttt(dd)  . . .  ttttt(dd)
sss <systemc> ttttt(dd)  ttttt(dd)  ttttt(dd)* . . .  ttttt(dd)

PATHS    NEIGHBOR          LDEV     STATUS
<pn>     ........ (sss)     xx      NOT READY (err)
<pn>    <system> (sss)      xx      READY (cpu,pin)
<pn>    <system> (sss)      xx      READY (cpu,pin)
-------------------------------------------------------

                                                      ——>
```

where

system (sss)

is the name (and number) of the system specified in the MAPS command.

nn

is the number of communication lines radiating from the selected system. This number indicates the number of rows and columns under TIME (DISTANCE) BY PATH and the number of paths listed at the bottom of the display.

date, time

is the date and time at which the display was made.

sss <systema>

is the number and name of one in a list of systems in the network.

ttttt(dd)

is the time(ttttt) and distance (dd) between systems in the network and the selected system. Each row and column represents a path that corresponds to the paths listed at the bottom of the display. For example, the third column in the first row represents the time and distance required to reach systema through path 3. An asterisk (*) shows that systema is connected to the selected system through this path; a plus sign (+) indicates that a connect request is outstanding, but the connection has not yet been established. A system that cannot be reached through a path is indicated by 32767(--).

ttttt represents the sum of the line-speed time factors that are specified for system generation. The smaller numbers represent faster lines.

dd represents the number of node-to-node paths traveled to reach systema through a particular end-to-end path.

⟶

pn

is the number of a path corresponding to a column under TIME (DISTANCE).

system (sss)

is the name and number of the system directly connected to the selected system.

xx

is the logical device number of the line handler. In the case of multi-line, it is the logical device number of the path.

(err)

is the file system error for a path that is not ready. This error usually is 66 for a device downed by the operator, 140 for modem loss, or 248 for a nonresponding remote system. In the case of a multiline path, if all lines are down, the error number will be for the fastest line in the path. For a more detailed description of the error, use the PATHS command.

(cpu,pin)

is the processor and process identification number of the current primary process of the line handler.

EXAMPLE:

This example shows the MAPS command issued for system 3, which is system \TS. This system has five paths radiating from it. The row filled with 32767(--) indicates that system 5 is not available. (A column filled with 32767(--) would indicate a path that is not available.) By looking at the time and distance column for a particular path, the presence of an asterisk indicates which systems are currently connected through that path.

```
>MAPS 3

 NETWORK MONITOR - T9007D05 - (01OCT80)

   NETMAPS AT \TS (003)    #PATHS=05   TIME:4 SEP 1980, 9:38:59

  SYSTEM
  2 \CUPRTNO     10(02)      5(01)*     51(03)     99(03)    ....
  4 \DALLAS      28(02)*    33(03)      74(04)    122(05)    ....
  5 \CHICAGO  32767(--)  32767(--)  32767(--)  32767(--)    ....
  6 \NEWYORK     41(03)*    52(02)      87(05)    135(05)    ....
  7 \QA          33(03)     33(03)      23(01)*   117(03)    ....
  8 \LA         104(04)    104(04)     140(04)     94(02)*   ....
  9 \CORP         5(01)*    10(02)      51(03)     99(04)    ....
 10 \PARIS       98(02)*   103(03)     144(04)    192(05)    ....
 11 \TORONTO     28(02)*    33(03)      74(04)    122(05)    ....
 14 \LONDON      57(03)     57(03)      93(03)     47(01)*   ....
 16 \SNMATEO     18(02)*    23(03)      64(04)    112(04)    ....

PATHS    NEIGHBOR          LDEV     STATUS
  1     \CORP     (009)     22      READY (07,007)
  2     \CUPRTNO  (002)     15      READY (06,006)
  3     \QA       (007)     18      READY (05,010)
  4     \LONDON   (014)     20      READY (04,009)
  5     ........  (000)     14      NOT READY (248)
-------------------------------------------------------
```

The first column, path 1, has six asterisks: one next to neighboring system 9 and one each next to systems 4, 6, 10, 11, and 16. Because systems 4, 10, 11, and 16 are only two hops away from the selected system, we assume that all are connected to system 9. System 6 can be connected to any of these systems.

The second column, path 2, has one asterisk next to neighboring system 2. However, systems 6 and 9 are only two hops away from the selected system; we assume that these systems are connected to system 2.

Figure 4-2 shows that systems 2, 6, 9, and 16 are interconnected; we can reach any of these systems through either path. The best path from the selected system to system 6 is path 1. Although the number of hops is greater by going through path 1, the travel time is less.

The third column, path 3, has only one asterisk to indicate the neighboring system 7. Because no other system is two hops from the selected system through this path, we assume that system 7 is not a through system--that is, we cannot go through it to get to any other system. Any communication from system 3 over this path to any system other than system 7 bounces back to system 3.

The fourth column, path 4, has only two asterisks, one next to the neighboring system 14 and one next to system 8. Because system 8 is only two hops away from the selected system, we assume that system 8 is connected to system 14. Any communication from system 3 over this path to any system other than 8 or 14 bounces back to system 3.

The elipses in the fifth column indicate that information has been omitted from this example so that the example would fit on this page.

From this information emerges a possible graph of this network, shown in Figure 4-2. This picture of the network shows the numbers used in SYSGEN to represent the line-speed time factors of the communication lines between systems. Adding these numbers along a path gives the result found in the sample MAPS display above.

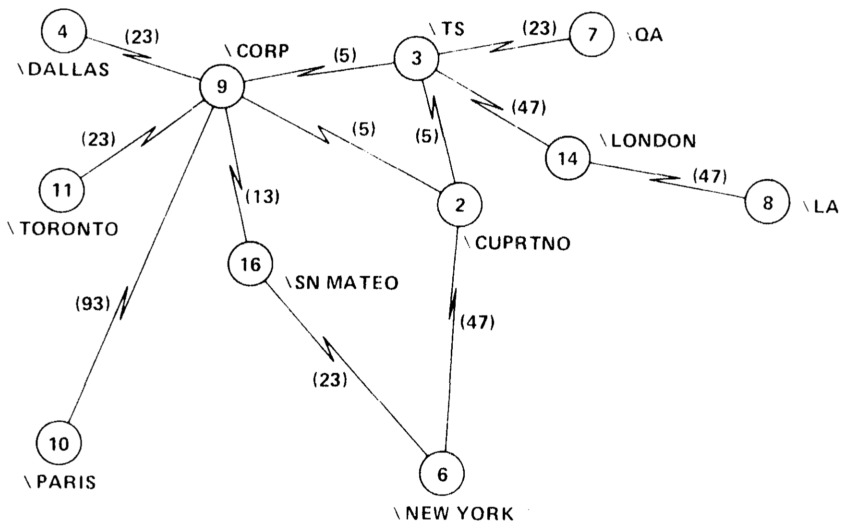


Figure 4-2. Graph of Sample Network Interconnections

PATHS Command

The PATHS command displays the status of a selected path and status of the lines comprising the path. The form of the command is:

```
PATHS [ system ]
      , [PATH pathnum ]


where

  system

    is a specific system name (e.g., \DALLAS) or system
    number (e.g., 3).  Status information for all paths in
    the system will be shown.  If this parameter is omitted,
    paths for the default system are displayed.


  PATH pathnum

    selects a specific path and displays its status.
    Omission of this parameter causes all paths to be
    displayed for the local system.
```

This command displays the status of paths, and the lines comprising each path, relative to a selected system. If no system is specified, NETMON displays the status of paths relative to the default system. The form of the display is:

```
   NETWORK MONITOR - T9007E02 - (01JUL81)

   PATHS AT system (sss)      # PATHS = nn      TIME: date, time

  PATH    NEIGHBOR    LDEV    TF   PID    LINE    LDEV    STATUS

 pathnum systema sss pathdev  tt cpu-pin
                                         lineno  linedev  status
                                         lineno  linedev  status



                                                              ⟶
```

where

system (sss)

is the name or number of the system specified in the PATHS command. The local system is used as the default if no parameters are supplied with the command.

nn

is the number of internodal connections radiating from the selected system. This number indicates the number of entries listed for the PATH column.

date, time

is the date and time at which the display was requested.

pathnum

is the path number for the particular entry displayed.

systema sss

is the name/number of the immediately adjacent system in this path

pathdev

is the logical device number of the path.

tt

is the time factor for the path (depends on the number of lines per path and the configured line speeds).

cpu-pin

is the number of the processor module where the net line handler is executing and the number of the process in that processor.

⟶

lineno

is the line number in a particular path. It can be one of several lines in the same path for multi-line.

linedev

is the logical device number of the line.

status

shows the status of the line in the form of a brief description and file system error number. For example, an error 66 indicates that a line downed by the operator caused a not ready condition.

The following example shows a network composed of three paths, two of which contain multiple lines. Because the PATHS command's optional parameters are omitted, all paths for the local default system, \TS (003), are displayed.

```
>PATHS

   PATHS AT \TS (003)     # PATHS = 4   TIME: 15 MAR 1981  10:33

PATH    NEIGHBOR      LDEV   TF    PID     LINE LDEV    STATUS

 1   \MANGO   (001)   10     35  (00,040)
                                            1    11  NOT READY(140)
                                            2    12      READY
                                            3    13      READY

 2   \SIBERIA(011)    20      5  (06,022)
                                            1    21      READY

 3   \MFG     (032)   30     --    -- ---
                                            1    31  NOT READY(248)
                                            2    32  NOT READY(066)

 4   ........(000)     0     --    -- ---

                                                                ⟶
```

where

\TS (003)

is the name and number of the system selected, in this example the default system.

# PATHS = 4

is the number of paths connected through this system

PATH 1

connects to neighbor system name/number \MANGO (001) and is accessed through logical device address LDEV 10. The time factor, dependent on the number of lines, is TF 35. The processid PID is (00, 040). This path is composed of three lines that are accessed through logical device addresses LDEV 11, 12 and 13. Line 1, LDEV 11, is not ready--file system error 140; lines 2 and 3, LDEV 12 and 13 are ready.

PATH 2

connects to system name/number \SIBERIA (011), is ready, and its status characteristics are similar to those of PATH 1.

PATH 3

connects to system name/number \MFG (032) and is accessed through LDEV 30. This path is not ready, as indicated by the null entry in the processid and factor TF --; both line 1 and 2, LDEV 31 and 32, show a not ready status--file system error 248 and 066 respectively.

PATH 4

this line was not brought up since the last system cold load, thus it shows null entries for all fields.

PERIOD Command

The PERIOD command sets the sample-interval time (in seconds) used by the DISPLAY command. The form of the command is:

```
PERIOD [sample]


where

  sample

    is the number of seconds over which the sample is taken.
    The range for sample is 10 through 600.  If this option
    is omitted, the current sample period is displayed.
    Where no sample period has been specified, NETMON assumes
    60 seconds.
```

CONSIDERATIONS. The sample-interval time occurs only after the completion of the last DISPLAY command and before the next request for node statistics is sent. In essence, the sample-interval is only a minimum time; it can be much longer.

PROBE Command

The PROBE command displays the current paths from one or all of the remote systems to the selected system. The form of the command is:

```
PROBE    [ system1 ]
         , [ PERIOD interval ]
         , [ SYSTEM system2 ]
```

where

system1

is either a system name or a system number from which the probe is made. If this option is omitted, the local system is assumed.

interval

is the number of seconds to wait between probes. The range for interval is 1 through 600. The probes continue until the BREAK key is pressed. If this option is omitted, the probe is performed once.

system2

is either a system name or a system number to which the probe is made. If this option is omitted, all systems in the network are probed.

The format of the display is:

```
   NETPROBES AT \<system>     (sss)         TIME: date, time

sss \systema - \system - \system - ... - \system - * (ttttt)
sss \systemb - \system - \system - ... - \system - * (ttttt)
      .
      .
      .
sss \systemn - \system - \system - ... - \system - * (ttttt)
```

where

system (sss)

is the name and number of the system selected in the PROBE command.

time: date, time

is the date and time that the PROBE was requested.

\system - \system

is the list of systems through which the probe is made.

*

is the system selected in the PROBE command.

ttttt

is the round-trip time for the probe in hundredths of a second ("tics").

EXAMPLES:

The first example shows that system 20 (whose name is \FRANKFT) is only two hops away from \LONDON (system 18).

```
  >PROBE \LONDON, SYSTEM 20
       NETPROBES AT \LONDON (018)     TIME: 24 FEB 1981, 12:38:25

    20 \FRANKFT - \SCHULNG - *  (00020)
```

The next example shows that only two systems, 2 and 7, are connected directly to the local system, which is \TS (003). Moreover, all systems except 7 are connected to system 3 through system 2.

```
>PROBE
     NETPROBES AT \TS (003)         TIME: 24 FEB 1981, 12:43:52

PROBE TO \SAA ** FAILED 250 **
  2 \CUPRTNO - *  (00007)
  4 \DALLAS - \NEWYORK - \CHICAGO - \MFG - \CUPRTNO - * (00053)
  5 \CHICAGO - \MFG - \CORP - \CUPRTNO - *  (00028)
  6 \NEWYORK - \CHICAGO - \MFG - \CORP - \CUPRTNO - *  (00039)
  7 \QA - *  (00005)
  9 \CORP - \CUPRTNO - *  (00010)
 10 \MFG - \CORP - \CUPRTNO - *  (00009)
```

SHOW Command

The SHOW command displays the systems selected with the ADD command. The form of the command is simply:

```
SHOW
```

with no options.

STATS Command

The STATS command displays detailed statistics that represent the communication occurring between the specified system and all the systems in the network. The form of the command is:

```
STATS [ system ]


where

  system

    is either a system name or a system number.  If this
    option is omitted, the local system is assumed.
```

The format of the display is:

```
                 NETWORK STATISTICS AT \system (sss)

   SYSTEM            LINKS(PKTS) SENT         LINKS(PKTS) RCVD
sss \systema           nnnnn(ppppp)             mmmmm(qqqqq)
sss \systemb           nnnnn(ppppp)             mmmmm(qqqqq)
sss \systemc           nnnnn(ppppp)             mmmmm(qqqqq)


where

  system

    is the system selected in the STATS command.


  sss

    is the system number.


  \systema

    is one of the systems that communicates with the selected
    system.
```

→

nnnnn

is the total number of link requests issued by this system since the last cold-load; wraps around.

(ppppp)

is the total number of packets sent from this system excluding pass-through packets since the last cold-load; wraps around.

mmmmm

is the total number of link requests received by this system since the last cold-load; wraps around.

(qqqqq)

is the total number of packets received by this system since the last cold-load; wraps around.

EXAMPLE:

This example shows that only systems 2, 7, and 9 are communicating with the specified system, \TS (003). Moreover, the network traffic for system 3 passes through system 2.

```
 >STATS 3
                NETWORK STATISTICS AT \TS (003)

    SYSTEM          LINKS(PKTS) SENT      LINKS(PKTS) RCVD
   2 \CUPRTNO          469(01133)            102(01132)
   4 \DALLAS             0(00000)              0(00000)
   5 \CHICAGO            0(00000)              0(00000)
   6 \NEWYORK            0(00000)              0(00000)
   7 \QA                47(00110)              8(00110)
   9 \CORP               6(00165)             54(00114)
  10 \MFG                0(00000)              0(00000)
  13 \HWR2               0(00000)              0(00000)
  14 \HWR                0(00000)              0(00000)
  15 \HWR1               0(00000)              0(00000)
```

THRESHOLD Command

The THRESHOLD command determines when to blink the rate of packets line in the display shown with the DISPLAY command. The THRESHOLD command checks the rate of packets in each sample period. When the difference between the previous rate of packets and the current rate reaches the specified percentage, the rate of packets line blinks for one sample period. The form of the command is:

```
THRESHOLD  [ percentage ]


where

  percentage

    is the percentage difference to be met to start blinking
    the rate of packets line.  If this option is omitted, the
    current threshold value is displayed.  If no threshold is
    specified, NETMON assumes 50 percent.
```

Messages

BACKUP PROCESS ALREADY EXISTS IN CPU nn
attempted to issue a second BACKUP command

BACKUP PROCESS CREATED IN CPU nn
successful completion of the BACKUP command

CENTRAL LOGGING INITIATED
self-explanatory

CENTRAL LOGGING TERMINATED
self-explanatory

COMMA EXPECTED
self-explanatory

CURRENT CENTRAL LOGGING SYSTEM IS: system (nnn)
response to LOGCENTRAL command without parameters

ILLEGAL CPU NUMBER
backup processor number must be between 0 and 15

ILLEGAL PARAMETER
attempt to use the HELP command for an unknown command

ILLEGAL SYSTEM NUMBER nnn
system numbers must be within the range defined with system generation (SYSGEN)

INVALID SYSTEM NAME
system name is unknown, name is too long, backslash is missing, or name has special characters (e.g., an ampersand)

INVALID SYSTEM NUMBER
system numbers must be within the range defined with system generation (SYSGEN)

MUST BE A NAMED PROCESS TO RUN NONSTOP
the NAME option in the RUN command must be specified

NCP ERROR nnn
unable to communicate with the Network Control Process (NCP) because error nnn occured while fetching data for the MAPS command.

NETMON BACKUP TAKEOVER
occurs when running NonStop

NETTRACE RCVD WAS BAD
improperly formatted trace message received from a remote system

NO CENTRAL LOGGING SYSTEM CURRENTLY ACTIVE
response to LOGCENTRAL command without parameters

NOMEM FOR NCP^READ
unable to obtain space for a MAPS message

NOMEM FOR NCP^WRITEREAD
unable to obtain space for a PROBE message

NO SYSTEMS AVAILABLE
no paths exist to other systems in the network; STATS command cannot retrieve information

NO SYSTEMS AVAILABLE FOR PROBING
no paths exist to other systems in the network; PROBE command cannot retrieve information

NO SYSTEMS SELECTED
systems are designated with the ADD command

NO SYSTEMS SELECTED FOR DISPLAY
systems are designated with the ADD command

PERIOD MUST BE BETWEEN 10 & 600 SECONDS
self-explanatory

PROBE TO system ** FAILED nnn **
file error nnn prevents the PROBE command from completing

SYSTEM IS NOT CURRENTLY AVAILABLE
system specified in the MAPS, PROBE, or STATS command is unavailable

SYNTAX ERROR
self-explanatory

THIS IS THE CENTRAL LOGGING SYSTEM
response to LOGCENTRAL command without parameters

THRESHOLD IS nnn%
response to THRESHOLD command without parameters

THRESHOLD MUST BE BETWEEN 1 AND 100 PERCENT
self-explanatory

TOO MANY PARAMETERS
self-explanatory

TOO MANY SYSTEMS REQUESTED, LIMIT IS 16
attempt to add more systems than can fit on a screen for a display

UNABLE TO CREATE BACKUP PROCESS IN CPU nn
occurs when running NonStop

UNKNOWN COMMAND
  self-explanatory

UNKNOWN KEYWORD
  self-explanatory

Syntax Summary

```
ADD     { ALL                        }
        { system [, system,...]      }

BACKUPCPU cpu

CPUS  [ system ]

DELETE    { ALL                       }
          { system [ ,system,...]     }

DISPLAY

EXIT

FC

HELP  [ ALL     ]
      [ command ]

LOGCENTRAL   [ OFF ]
             [ ON  ]

MAPS [ system ]

PATHS [ system ]
      , [ PATH pathnum ]

PERIOD [sample]

PROBE [ system1 ]
      , [ PERIOD interval ]
      , [ SYSTEM system2 ]

SHOW

STATS [ system ]

THRESHOLD  [ percentage ]
```

NETWORK SECURITY

This section discusses network security. The reader should already be familiar with one-system security as described in the GUARDIAN Operating System Programming Manual, Volume 2.

Overview

Security in a network is more restrictive than security on a single system. The security philosophy of the system--that the machine serves a community of cooperating, intelligent users--does not extend to a network, in which nothing about the remote-user community can be controlled or assumed.

Therefore, while the security system on one system allows any operation that is not specifically prohibited, the security on a network prohibits any operation that is not specifically allowed. Prior cooperation between system managers at each node is required before a user at one system can access another.

A user at system X wishing to access a file (disc file, device, or process) residing on system Y must satisfy each of these three requirements:

- the user at system X must also be a user at system Y
- the user must have matching REMOTEPASSWORDS set up at both system X and system Y
- the user at X must have sufficient capability to access a disc file at Y.

Each of these three security levels is discussed below.

Global Knowledge of User IDs

Each system user is known to the machine by a user name, such as ADMIN.BILL, and a user identifier, such as 8,4.

A user has access to files on a remote system only if that user's name and ID are known to the remote system.

Thus if ADMIN.BILL, whose user ID is 3,46, wishes to access a file on a remote system, the remote system must also have a user named ADMIN.BILL whose user ID is 3,46.

Remote Passwords

Once the user identifiers of network users have been added to each node, a system of remote passwords is used to specify whether remote access is permitted.

Each user ID has associated with it a set of remote passwords. One, specified with the command:

```
:REMOTEPASSWORD \this system name, remote password
```

designates the password required for a remote user to access this system. The others, specified by:

```
:REMOTEPASSWORD \remote system name, access password
```

define passwords used in your subsequent attempts to access remote systems; such an attempt is successful if the remote-access password you associate with the remote system matches the remote-owner password previously specified by the remote user.

Each type of password consists of as many as eight nonblank characters. Control characters are allowed, and lowercase characters are not upshifted.

Consider two systems in a network, named \A and \B. On each system, a user named ADMIN.BILL with user ID 3,46 has been defined.

At system \A, a user types the commands:

```
:LOGON ADMIN.BILL
:REMOTEPASSWORD \A, shazam
```

"shazam" is ADMIN.BILL's remote-owner password. From now on, a user logged onto a remote system as ADMIN.BILL must specify "shazam" as his remote-access password to access system \A. For example, a system \B user enters:

```
:LOGON ADMIN.BILL
:REMOTEPASSWORD \A, shazam
```

This user now has remote access to \A as ADMIN.BILL, and can now perform operations such as creating processes and accessing certain disc files. However, when \B can access \A but \A cannot access \B, the ability to create processes on \A is not useful. The process is liable to want to access the home terminal, which is an attempt to access \B from \A, which is not permitted. Once passwords for both directions of access are established, everything works.

A remote password, once defined, remains in effect until modified by a subsequent REMOTEPASSWORD command. ADMIN.BILL can log off and then log on again without having to respecify his remote passwords.

ADMIN.BILL, logged on at system \B, does not have quite the same status on \A as the ADMIN.BILL on \A. ADMIN.BILL on \B is a remote accessor of \A; consequently, he cannot access disc files on \A that specify "local access only". The next section explains disc file security.

Moreover, ADMIN.BILL on \A still has no access to system \B. For ADMIN.BILL to gain access to \B, a remote-owner password must be defined for ADMIN.BILL at \B, and matched by a remote-access password at \A. For example, at \B:

```
:LOGON ADMIN.BILL
:REMOTEPASSWORD \B, aardvark
```

and at \A:

```
:LOGON ADMIN.BILL
:REMOTEPASSWORD \B, aardvark
```

Now ADMIN.BILL at \A can access \B.

These considerations apply to remote passwords:

- As in the example above, the absence of a remote-owner password prevents remote access as that user. Thus, if MARKET.SUE does not supply a remote-owner password, no remote user with the same user ID can access MARKET.SUE's system.

- The command:

  ```
  :REMOTEPASSWORD \<system name>
  ```

  removes any previously designated password (either for the local system or a remote one). The command:

  ```
  :REMOTEPASSWORD
  ```

  removes all remote passwords.

- A remote-access password can be issued before the corresponding remote-owner password. Remote access becomes legal as soon as both remote passwords have been defined (provided that they match).

- A remote password can be specified for a remote system even though that system is not currently known or connected to the user's system. After the remote system is placed in the network and the remote user specifies the correct remote password, access to the remote system may begin.

- Remote passwords are independent of the regular passwords defined for each user. In the example above, ADMIN.BILL at either system could issue the command:

  ```
  :PASSWORD <local password>
  ```

  to prevent unauthorized individuals from logging on as ADMIN.BILL on that system.

Disc File Security

For each disc file, the user specifies the access level required to read, write, execute and purge the file. Access levels are set in one of two ways:

- by using the FUP SECURE command; for example,

  ```
  :FUP SECURE MYFILE, "AGO-"
  ```

- by using SETMODE function 1, "set disc-file security"; bit fields in the first parameter 1 specify the read-, write-, execute-, and purge-access via numbers.

Access levels "A", "G", "O", and "-" imply local access only:

A	any local user can have access
G	members of the file owner's group
O	owner only
-	super-ID only

Classes of network users "N", "C", and "U" are defined thus:

- A network user (N) is any accessor on any system.
- A community (C) is an "extended group" including any accessor, anywhere on the network, whose group id matches the owner's group id. Thus, user 8,4 on system \NEWYORK and user 8,17 on system \DETROIT are members of the same community.
- A user class (U) is an "extended owner"; it includes any accessor throughout the network whose user ID matches that of the owner. Thus, user 8,4 on \NEWYORK and user 8,4 on \DETROIT are members of the same user class.

A disc file can have any of these levels specified for read-, write-, execute-, and purge-access, using the numeric value with the SETMODE procedure or the corresponding letter in the FUP SECURE command. The levels are summarized in Table 4-2.

Table 4-2. Local and Remote Access Codes

Numeric Value (SETMODE)	Letter (FUP)	Meaning
0	A	any local accessor
1	G	any local group member
2	O	owner only
4	N	any network accessor, local or remote
5	C	any member of owner's community
6	U	any member of owner's user class
7	-	local super-ID

Except for the super-ID, the numeric values for network access are found by adding 4 to the corresponding local access levels.

Note that SUPER.SUPER has no special authority to access remote files; no user, including SUPER.SUPER, can access a remote disc file having "A" security.

Default File Security

Users can specify their own default file security, which is automatically assigned to any files that they create.

Default file security is set with the DEFAULT command of the command interpreter. For example, the commands:

```
:LOGON ADMIN.BILL
:DEFAULT $SYSTEM.MYFILES, "NAOO"
:LOGON ADMIN.BILL
```

cause any disc files created by ADMIN.BILL to automatically have file security "NAOO". Note that until his next LOGON command, the user's old default disc file security remains in effect.

EXAMPLES:

The combination of user IDs, remote passwords, and disc file security lets users tailor network security to their specific needs. These examples demonstrate some possible ways to implement network security.

Example 1 (Local and Remote Users): Accessors of a file are classified as either "local" or remote" with respect to that file. A local user is one who is logged on to the system on which the file resides; a remote user is one logged on to a different system.

A remote accessor of a system can become a local accessor by simply running a command interpreter in the remote system, and logging on. For example, if ADMIN.BILL on \A has specified the proper remote password to gain access to system \B, he can issue the commands:

```
:WAKEUP OFF
:\B.COMINT
:LOGON ADMIN.BILL
```

He is now logged on as the local ADMIN.BILL on system \B. Thus, he can access disc files on \B owned by ADMIN.BILL having security "O". This remote session is terminated with a control-Y or LOGOFF. In the case of a control-Y, the command interpreter then asks "Are you sure you want to stop your command interpreter on \B?" Reply YES to awaken the local command interpreter. In the case of a LOGOFF, the command interpreter simply responds with "Exiting from CI on system \B."

System \B can prevent a remote user from becoming a local user in a number of ways. One method is to specify "A" as the "execute" security for $SYSTEM.SYSTEM.COMINT, preventing anyone in any remote system from running the program file.

Another way to prevent ADMIN.BILL, on \A, from logging on to \B is to simply give ADMIN.BILL at \B a local password that is unknown to ADMIN.BILL at \A.

Example 2: Suppose that there are so many systems in the network that nobody wants to type all the required REMOTEPASSWORD commands, but it is important to deny network access to certain users.

At each node, establish a user called NET.ACCESS, and issue the following commands:

```
:LOGON NET.ACCESS
:PASSWORD local password
:REMOTEPASSWORD \system 1, global password
:REMOTEPASSWORD \system 2, global password
    .
    .
    .
:REMOTEPASSWORD \system n, global password
```

The global password is the same for all systems and is known only to the system managers; the local password is different for each system and is given to those users who are allowed to access the network.

Only those users who know the local password can log on as NET.ACCESS. The command:

```
  :LOGON NET.ACCESS, local password
```

allows them to access remote files.

Example 3 (Sub-Networks): In a large network, it may be desirable to allow users to access some nodes, but not others. For example, you might want to allow users on system \SANFRAN to be able to access systems \LA, \SEATTLE, and \CUPRTNO, but not \NEWYORK and \CHICAGO.

In this case, the idea used in Example 1 can be extended to allow access to any number of subnets, where a subnet is defined simply as any collection of individual nodes. A user named NET.WEST is established at each node of the subnet, and a password scheme such as the one in Example 2 is used to allow certain users to log on as NET.WEST.

Subnets implemented in this manner can be allowed to overlap or include one another. For example, \CHICAGO might be accessible from \NEWYORK, by logging on as NET.EAST, and from \PHOENIX, by logging on as NET.MIDWEST. Similarly, each node in the entire network might have a user NET.GLOBAL, who is allowed to access every other node.

Example 4 (Defining the Capabilities of SUPER.SUPER): On a single system, SUPER.SUPER is allowed access to any file. On a network, the user can define whether the powers of the super-ID are local, global, or somewhere in between.

To make SUPER.SUPER a local super-ID only, do not issue a REMOTEPASSWORD command for SUPER.SUPER at any node. This prevents a remote super-ID from accessing the node's files.

To make SUPER.SUPER a global super-ID, issue, at each node, REMOTEPASSWORD commands as in Example 2, so that SUPER.SUPER can access files on remote systems, and give every SUPER.SUPER the same password. Now, if a disc file has security "A", "G", "O" or "-", a remote super-ID can still gain access to the file by running a command interpreter in the system containing the disc file, and logging on as the local SUPER.SUPER.

To make SUPER.SUPER an in-between super-ID, issue, at each node,REMOTEPASSWORD commands as in Example 2, so that SUPER.SUPER can access files on remote systems. Additionally, issue each SUPER.SUPER a distinct password. Then, any disc file can be protected from remote access by giving it "A", "G", "O", or "-" security; a remote SUPER.SUPER cannot log on as the local one, since the local super-ID's password is unknown.

Process Access

Several security considerations relate to remote processes:

- With respect to a given system, each process in the network is either "local" or "remote", according to these rules:

  - A process is remote if it is running in a remote system.

  - A process is remote if its creator is in a remote system.

  - A process is remote if its creator is remote.

  According to the second and third rules, even a process running in a particular system can be remote with respect to that system. These rules prevent a user from remotely running a process that creates another process that accesses a file whose security specifies "local access only".

- A remote process cannot suspend or activate a local process. A remote process cannot stop a local process, unless the local process's stop mode is 0 ("anyone can stop me").

- A remote process can not put a local process into DEBUG.

It is possible for a process that is remote with respect to the system in which it's running to become local. For instance, Example 1, above, characterized users as either local or remote on the basis of where they are logged on. The example also showed how a user in system \A could become local with respect to \B by running a command interpreter at \B and logging on.

Consider the command interpreter in \B. Its creator is the user's command interpreter in \A; thus, the command interpreter in \B is remote with respect to \B. But the user's LOGON command causes that command interpreter to become local with respect to \B. Thus, if you allow the possibility of a process somehow making itself local with respect to the system in which it's running, the concept of local and remote users becomes equivalent to the concept of local and remote processes: a user is local (remote) with respect to a given system if his command interpreter is local (remote) with respect to that system.

A process that makes itself local with respect to the system in which it is running is said to "programmatically log on" to that system.

Programmatic Logon (VERIFYUSER Procedure)

Programmatic logon is accomplished by calling the VERIFYUSER procedure, which verifies a user's password and optionally allows a process to programmatically log on (i.e., make the user's ID its own, and become local with respect to the system in which it is running).

The call to VERIFYUSER is:

```
CALL VERIFYUSER  ( user name or id
                 , logon
                 , default
                 , default length)
```

where

user name or id, INT:ref:12,

is an array containing either the name or user ID of the user to be verified or logged on, where either:

```
user name or id [0:3]  = group name, blank-filled
user name or id [4:7]  = user name, blank-filled
user name or id [8:11] = password, blank-filled

  or,

user name or id [0].<0:7>    = group ID
user name or id [0].<8:15>   = user ID
user name or id [1:7]        = zeros (ASCII nulls)
user name or id [8:11]       = password, blank-filled
```

logon, INT:value,

if present, verifies the user and, if its value is nonzero, logs on; if it is zero, is does not log on. If this option is omitted, a value of 0 is understood.

⟶

default, INT:ref:18,

if present, is returned information regarding the user specified in user name or ID:

```
default [0:3]       = group name, blank-filled
default [4:7]       = user name, blank-filled
default [8].<0:7>   = group ID
default [8].<8:15>  = user ID
default [9:12]      = default volume, blank-filled
default [13:16]     = default subvolume, blank-filled
default [17]        = default file security,
                        as follows:

  default [17].<4:6>   = read    (0 = "A"   4 = "N")
  default [17].<7:9>   = write   (1 = "G"   5 = "C")
  default [17].<10:12> = execute (2 = "O"   6 = "U")
  default [17].<13:15> = purge   (7 = "-")
```

default length, INT,

is the length, in bytes, of the default array. This number should always be specified as 36; in the future, new fields can be added to default, requiring default length to become larger.

These condition code settings are effected by the VERIFYUSER procedure:

< (CCL)	indicates that a buffer is out of bounds or an I/O error occurred on the user-ID file.
= (CCE)	indicates a successful verification and/or logon.
> (CCG)	indicates that there is no such user, or the password is bad.

CONSIDERATIONS. After a successful logon using this procedure, a process is considered to be local with respect to the system in which it is running.

A process that passes a bad password to VERIFYUSER for the third time is suspended for 60 seconds.

EXAMPLE:

```
  USER := 3 '<<' 8  +  17;         ! user ID 3,17
  USER[1] ':=' 0 & USER[1] FOR 6; ! all zeros
  USER[8] ':=' PASSWORD FOR 8;
  LOGON := 1;               ! log this user on
  CALL VERIFYUSER( USER, LOGON, DEFAULT, 36 );
  IF < THEN ...             ! buffer or I/O error
  ELSE IF > THEN ...        ! no such user, or bad password
  ELSE ...                  ! successful
```

NETWORK MANAGEMENT CONSIDERATIONS

To develop and manipulate an EXPAND network it is necessary to use several Tandem-supplied programs and subsystems. These programs include: SYSGEN, CUP, PUP, CMI, and XRAY. The following discussion gives a brief description of each program and points out any special considerations for their use.

System Generation (SYSGEN)

The System Generation (SYSGEN) program generates an Operating System for a given hardware/software configuration. Network management considerations for running SYSGEN for an EXPAND network include:

- Maximum system number (max systems). This network global SYSGEN parameter specifies the maximum number of systems in the network and establishes an upper bounds on the system numbers that will be recognized. Peculiar results occur if the value of max systems is not agreed to by all systems in a network.

  Consider the example of a network composed of \SYSTEMA (90) and \SYSTEMB (10). If \SYSTEMA is assigned a max systems value of 100 and \SYSTEMB is assigned a max systems value of 10, then \SYSTEMB will never recognize a connect message sent from \SYSTEMA because the max systems value for \SYSTEMA does not fall within the bounds specified for \SYSTEMB.

  Thus, even though connected properly in all other respects, the two systems will never be able to communicate. To resolve the problem, change the max systems value to be compatible in one or both systems and run another SYSGEN in each modified system.

- Establishing an EXPAND link using an X.25 line. As mentioned in Section 1 of this manual, it is possible to connect two systems via EXPAND using an X.25 network. To accomplish this you must perform the following three steps. First, SYSGEN an X.25 line with the correct subtype to connect to the specific vendor X.25 network (such as Telenet, Tymnet, Datapac, or

Transpac). Next, SYSGEN an EXPAND line (type NET^X25) as a separate LDEV. After the system is running, use CUP to ADD the EXPAND line as a subdevice to the X.25 line and to specify the various line parameters (see AXCESS, Volume 1: Introduction and Communications Utility Program).

- Line time factor. The LINESPEED parameter contains the value of the line time factor (recommended values are given in the SYSGEN section of the GUARDIAN System Management Manual). However, any value may be selected. In fact, the network manager may cause the NCP to select a new "best path" by assigning an LINESPEED value small enough where a particular path is always selected.

- All lines in a multiline path must be in the same controller group and run in the same cpu. If lines are distributed across multiple controllers to increase reliability, performance could be reduced by a controller ownership switch to the backup cpu. An ownership switch results if the following conditions are true: a non-EXPAND line (such as AM3270) connected to this controller group fails with an error in the range 210-226. Failure of a line in an EXPAND multi-line path, however, does not cause an ownership switch.

Communications Utility Program (CUP)

The Communications Utility Program (CUP) allows access to data communication lines in the EXPAND network environment. Operations performed by CUP include:

- initiate line traces via the TRACE command
- modify communication line or subdevice characteristics via the ALTER command
- list the SYSGEN configured communication line handlers via the LISTLH command
- add communication subdevices to an existing line handler via the ADD command
- list attributes of a particular line, subdevice, or group of subdevices via the SHOW command
- display line and subdevice statistics via the STATS command; optionally resets the statistics
- display a previously generated TRACE output file via the DUMP command
- display system-related network information via the SHOW command

The CUP TRACE facility now allows the Network Control Process (NCP) as well as the line handler to be traced. The NCP supplies CUP with the following information:

- NCP messages sent and received on a network path
- Action and state changes caused by the receipt or transmission of a message, or an event (internal or external) on both an internodal path and end-to-end path.

The CUP STATS command displays statistical information for the default line; default established through CUP LINE command. Line statistics are useful in determining optimal values for configuration parameters:

- "NO BUFFER" indicates the number of times the L2 dedicated buffer was full. This is not an error, but a warning that the next frame will be discarded if the buffer is not emptied. If the count is > 10% of the number of I-frames received, the size of the L2 dedicated buffer should be increased.
- "BUFFER USAGE" maintains a count of line handler usage of IOPOOL. If the value for BUFFER USAGE approaches the SYSGEN value specified for the processor, the configured size should be increased.

The CONNECT and CLEAR commands establish and terminate connection to an X.25-type device. For a detailed description of how to use CUP, refer to AXCESS, Volume 1: Introduction and Communications Utility Program (CUP).

Peripheral Utility Program (PUP)

The Peripheral Utility Program (PUP) performs various functions related to the peripheral devices connected to the system. Those functions related to the EXPAND network include:

- the DOWN command removes a line/path from service. If ! is specified, any current activity on the line is aborted. If ! is not specified, the line is removed from service only if there is no current activity on the line.
- the UP command places a downed line/path back into service. For NET^X25 lines, connection to the network must have been made previously through CUP.
- the LISTDEV command displays configuration characteristics for a given line/path.

PUP is described in the System Operations Manual.

Console Logging Messages

Two commands (CUP ALTER MSGON/MSGOFF and PUP CONSOLE ENABLE/DISABLE) work together to determine the manner in which network-related console messages are handled:

- the CUP ALTER MSGON/MSGOFF command may selectively enable/disable network messages (43, 46, 48, and 49); messages (44, 45 and 47) are always enabled. In the event that these messages are disabled, the NCP discontinues sending them to the operator process. This results in no message logging to the disc-resident operator log and a reduction of traffic queued to the operator process. Remote logging, however, overrides the CUP ALTER disable. In this case, the NCP simply sends all messages to the system designated as the LOGCENTRAL system.

- the PUP CONSOLE ENABLE/DISABLE command enables/disables the printing of the messages on the local system's console. A preliminary scan by the NCP checks whether the CUP ALTER command has enabled/disabled the messages. If enabled through CUP, they are sent to the operator process where the PUP CONSOLE enable/disable message list is checked to determine whether to print or not print the message at the console. However, if disabled by CUP, the messages are never sent to the operator process, thus nullifying the effect of the PUP CONSOLE enable/disable.

EXPAND Line Connection to an X.25 Line

The following example shows how to bring up an EXPAND line connection to an X.25 line (It is assumed that the X.25 line ($X25LIN) and the EXPAND line ($EXPLIN) have previously been defined through execution of the SYSGEN program.):

```
PUP DOWN ! $X25LIN

CUP

> LINE $X25LIN

> ALTER NETADDR 311041500091

  ! NETADDR is the X25 network address for this line

> ADD #NETLIN, PROTOCOL NET, TYPE (63,0), RECSIZE 256,
     LHLDEV 25, NEXTSYS 3, ADDR 311041500091, PORT 77

  ! RECSIZE is the EXPAND packet size in bytes
  ! LHLDEV is the logical device number for $EXPLIN
  ! NEXTSYS is the system number of the EXPAND node connected
  !   by $EXPLIN
  ! ADDR is the X25 network address of the EXPAND subdevice on
  !   the other end of this virtual circuit
  ! PORT is the X25 port number on the line specified by
  !   NETADDR

> EXIT

PUP UP $X25LIN
PUP UP $EXPLIN

CUP

> LINE $X25LIN

> CONNECT #NETLIN

  ! causes the EXPAND line handler to ask the X25 AXCESS method

  ! to place a call out to the address in subdevice #NETLIN

> EXIT
```

Communications Management Interface (CMI)

CMI is used to describe and control characteristics of both 6100CSS Communication Subsystems and non-6100CSS subsystems. Detailed information about CMI is given in the _Communications Management Interface (CMI) Operator's Guide_.

There are three EXPAND object types that can be defined and manipulated through CMI. These are:

PATH	a multi-line communication path
LINE	a single communication line
PROCESS	the EXPAND CAP process

Various CMI commands permit descriptive and operational control over these object types. The descriptive commands include:

ALTER PATH	INFO PATH
ALTER LINE	INFO LINE
ALTER PROCESS	INFO PROCESS

The operation commands include:

ABORT PATH	STATUS LINE
ABORT LINE	STOP PATH
CONTROL LINE	STOP LINE
START PATH	TRACE PATH
START LINE	TRACE LINE
STATUS PATH	

Refer to Appendix H of the _Communications Management Interface (CMI) Operator's Guide_ for a detailed description of CMI characteristics.

XRAY Program

XRAY is a tool for monitoring the performance of a Tandem system. XRAY monitors:

- cpu use
- line use
- NCP or line handler process use of system resources

For detailed information on how to use XRAY, refer to the XRAY User's Manual.

SECTION 5

FIBER OPTIC EXTENSION (FOX)

NOTE

This product is available only on the Tandem NonStop II system. It cannot be used on the Tandem NonStop system.

INTRODUCTION TO FOX

Tandem NonStop II systems are limited to 16 processors per system. Further expansion is possible only by accessing other Tandem systems across a network. Using conventional line speeds such as those available under EXPAND, sending a message between systems in a network is noticeably slower than sending a message between two processors within the same system because the message must be received and retransmitted by each intervening system. Even if there are no intervening systems, messages are slowed by line handler intervention. The Fiber Optic Extension (FOX) network was developed to allow much faster transfers of information between systems.

In the FOX network, a system is called a cluster. The FOX network is always a ring of systems. Each cluster is a NonStop II system of up to 16 processors. Up to 14 clusters can be included in the ring. Each cluster can communicate with other clusters in the ring. Each cluster can be located up to 1000 meters (1 kilometer) from the next cluster. Further, FOX clusters can be a part of a larger GUARDIAN/EXPAND network containing a mixture of other forms of communication links.

The FOX network, using fiber optic lines between clusters, can attain speeds up to 1 million bytes per second. Furthermore, messages usually pass directly from the sending processor to the bus and always pass through only the controllers of intervening systems (avoiding the line handlers).

Once FOX is installed, there is no external change apparent to the user. Externally, FOX appears as a high-speed connection between any two clusters on the FOX ring. The user interface to the FOX network is based on the user interface to EXPAND. To programmers, a cluster in a FOX ring looks like any other system in an EXPAND network, and is referenced in the same way.

Messages between systems are sent over the FOX network, if it is available, and can be sent over previously established EXPAND lines if FOX is not available. Availability is determined by whether both systems have been designated as FOX clusters, and whether a FOX link exists between the two.

THEORY OF OPERATION

A FOX ring of clusters is illustrated in Figure 5-1. Note that communication between two clusters is possible over either the X bus path or the Y bus path. These paths are extensions of the X and Y interprocessor buses of each cluster. Because the clusters are laid out in a ring pattern, communication is also possible in two directions. As a result, four paths are available. Communication between two clusters can occur over any of the four available paths between them. Each different path is tried until communication is successful. The first direction tried is that defined as the preferred direction in the SYSGEN configuration.

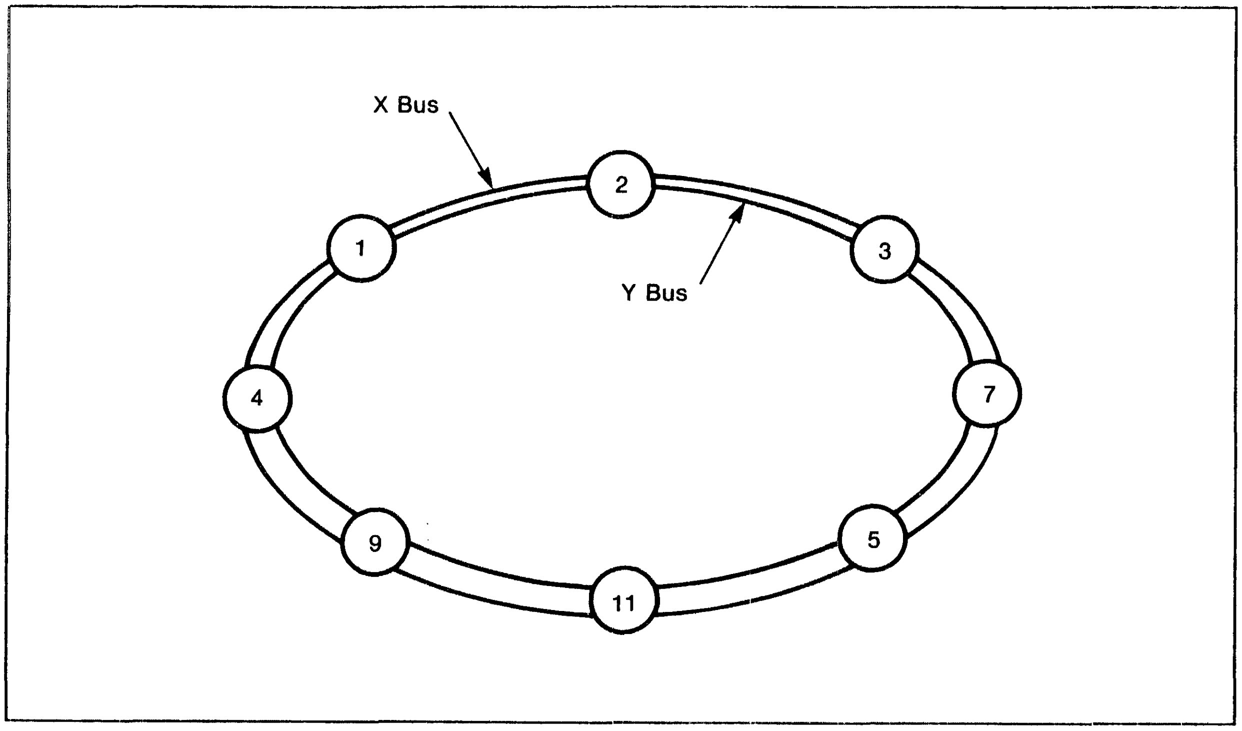


Figure 5-1. FOX Network Ring

The FOX network continues to operate even if three of the four paths fail. In fact, communication is usually not interrupted even if the ring is broken to add another FOX cluster. Processors can still be replaced or added online because there is no change to the X and Y bus structure.

If a transmission via the preferred path between two clusters fails, the next preferred path of the remaining three paths is automatically tried. For example, if a message is to be sent from cluster 1 to cluster 3, the shortest path is via cluster 2 (See Figure 5-1).

If cluster 2 is removed from service but the Serial Link Board (SLB) of its local bus unit is not powered off, messages can still be routed through it. If the SLB of the local bus unit is powered off, messages can still be sent around the ring in the other direction.

Local Bus Unit

The local bus unit both controls the local interprocessor bus and sends and receives packets over the ring network. Configuration of local bus units is illustrated in Figure 5-2. A ring can have from 2 to 14 clusters. Each cluster must have a unique cluster number in the range of 1 through 14. Cluster number 15 is reserved for special functions. Cluster number 0 is used to send a message from one processor to another processor within the same cluster.

There are actually four optical fiber cable connections between each pair of adjacent clusters in the FOX network; one pair (for outgoing and incoming lines) for each of the two buses. Each cable terminates at a controller which consists of a set of three FOX circuit boards for each bus. These boards are the Serial Link Board (SLB), the Control Processor Board (CPB), and the Interprocessor Bus Control (IPC). The controller which is made up of these three boards is known as the Local Bus Unit (LBU).

The basic FOX network is made up of local bus units interconnected in a ring. Every cluster has a local bus unit for each bus.

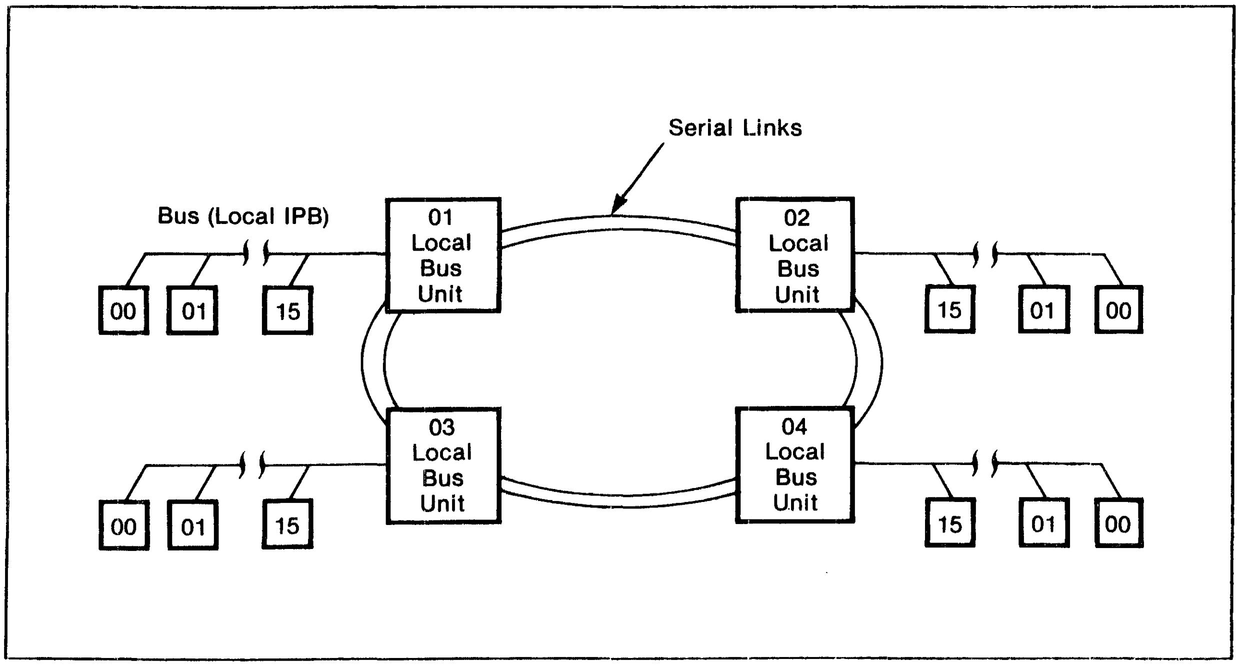


Figure 5-2. Ring Structure Showing Local Bus Units

As long as the ring is not broken, a packet can be sent in either direction and be assured of reaching its destination. In most cases, however, one direction is shorter than the other. The sending processor determines the direction defined at installation as the preferred path and passes the routing information to the local bus unit when sending data. A response to the message is usually returned via the same path as it was sent. If a message is not acknowledged as delivered, all four message paths are tried, in sequence, until the message is delivered or until all paths are shut off because of too many RESEND errors.

Local bus units are controlled by the GUARDIAN interprocessor bus monitor process. The interprocessor bus monitor process is controlled by CMI commands. The interprocessor bus monitor process is described later in the section. The CMI commands are described in Appendix K of the Communications Management Interface (CMI) Operator's Guide.

Line Handlers

Conventional EXPAND line handlers communicate over low-speed telephone lines; FOX line handlers communicate directly over the interprocessor bus extension. Messages not requiring security checking usually bypass the line handlers, traveling directly over the interprocessor bus extension from the sending process to the destination process.

The FOX line handler plays a role in many ways analogous to that of the conventional EXPAND line handler. The FOX line handler interfaces with the Network Control Program to establish and manage the connection of clusters in the same manner as it does in EXPAND. Also, the line handler handles the routing of packets for traffic that is being forwarded; thus, if a FOX cluster receives messages from a conventional EXPAND line handler that must be forwarded to another FOX cluster, the messages are passed through on a packet-by-packet basis as in conventional EXPAND.

Information on the configuration of FOX line handlers appears in the System Management Manual.

INTERPROCESSOR BUS MONITOR PROCESS

The GUARDIAN interprocessor bus monitor process for NonStop II systems controls the state of the Local Bus Unit (LBU). It also controls the downloading of the Loadable Control Store (LCS) with the correct firmware for the LBU.

The interprocessor bus monitor process must be defined at system generation as a dummy I/O device. It can be assigned any name. For ease of reference in this document, it is always referred to as $IPB.

Systems using the FOX network must specify one $IPB process at system generation. Both FOX and $IPB must be generated into the system, as described in the SYSGEN sections of the System Management Manual. $IPB is controlled by CMI commands, as described in Appendix K of the Communications Management Interface (CMI) Operator's Guide.

$IPB can be run on NonStop II processors without FOX. However, most features of $IPB are available only when FOX is installed.

Summary of Key Features

LOCAL BUS UNIT (LBU) MANAGEMENT. When the LBU is installed, $IPB monitors the Local Bus Unit, using a special function packet interface to poll for controller status and error data. $IPB is responsible for correct loading of firmware into the Loadable Control Store.

MESSAGE SYSTEM PROTOCOL SUPERVISION. $IPB controls the state of individual physical links (X/Y, left/ right) to remote clusters and individual buses to all processors. Certain error status data generated by message system operations is passed to $IPB by the monitor process of the processor which encountered the error.

DIAGNOSTIC SUPPORT. The EPROM resident self-test on the FOX controller and a downloadable Extended Self Test are executed as a step of the procedure by which the LBU is downloaded with operational code. Error statistics and status can be displayed by using CMI commands described in Appendix K of the Communications Management Interface (CMI) Operator's Guide.

ACTIVE INTER-CLUSTER LINK MONITORING. $IPB establishes communication with its counterparts in other clusters on a FOX ring using a low-level handshaking protocol that coexists with, and is independent of, the inter-cluster bus protocol used by the message system. This enables $IPB to continually test the state of the FOX ring and to collect status information for diagnostic and maintenance purposes. This information can be retrieved by use of CMI commands described in Appendix K of the Communications Mangagement Interface (CMI) Operator's Guide.

Detailed Functional Specifications

LOCAL BUS UNIT MANAGEMENT. The $IPB process is responsible for controlling the state of the LBU. When a primary $IPB process is initialized, it determines the state of the X and Y bus controllers by requesting LBU status. Persistent failure to obtain a response to the status request is recognized as an indication that the FOX network has not been installed, or that an error condition exists.

If $IPB gets answers to its status requests, then $IPB can bring the controllers to the appropriate state. This can require loading the operational firmware into the controller if it is not already running the correct version. The user can specify through SYSGEN whether the controller is to be started or stopped initially, and whether the firmware is to be replaced if the executing firmware is not identical to the firmware indicated in the microcode file.

Once initialization is complete, $IPB will maintain the status of the controller by periodically querying its status using special function packets. The state of the controller can be modified through use of the CMI commands START, STOP, and ABORT. The name of the operational firmware file to be used can be changed with the ALTER command.

$IPB is responsible for correct recovery from power failures that cause loss of the operational firmware.

Each time the FOX boards are powered on, or the reset button is pressed, the LBU runs a self-test diagnostic on the boards. When a START command is issued, $IPB checks the hardware ID of the LBU and downloads an appropriate operational loader module (LOADER). LOADER downloads the extended self-test module (EXTSELFTST). Then LOADER downloads the standard firmware module (STANDARD) which handles normal FOX traffic.

INTER-CLUSTER PROTOCOL SUPERVISION. $IPB receives error information generated by the GUARDIAN message system during the transfer of messages between clusters. This includes the shutting down of paths as a result of send timeouts and resend (WACK) timeouts. This information is also reported by the message system to the operator device and disc log as usual. $IPB must receive this information to support the diagnostic process and to maintain current status information on all paths.

ACTIVE INTER-CLUSTER LINK MONITORING. $IPB continually monitors the state of all paths to every system in the ring with an active $IPB. This is accomplished through use of a low-level handshaking protocol that uses special unsequenced packets. A class identifier in the packet allows the packets used by $IPB and the packets used by FOX line handlers to coexist without interference or confusion. $IPB can establish and maintain handshaking continuity independent of EXPAND logical connections between the systems. Also the status information exchanged through handshaking packets permits every $IPB to have a comprehensive view of the state of the FOX ring. This aid is important to systems diagnosis and maintenance.

FOX controllers exchange "I'm alive" messages with their neighbors that include the cluster number of the sending controller. This allows $IPB to determine the cluster numbers of its operational neighbors. These FOX "I'm alive" messages are not to be confused with the "I'm alive" messages exchanged between system processors.

In addition, the controllers also send "My host is alive" messages. These messages contain the cluster number and CPU number of the last special function packet requesting status information from the LBU. If such a packet is not received within a time interval of approximately 30 seconds, the controller assumes that its host is dead. When this occurs, the controller enters a state in which the "My host is alive" messages are allowed to pass through; these messages include the cluster and CPU being received from the LBU in the opposite direction. Thus, every controller retains the identity of the CPU containing the next adjacent system with an "alive" $IPB in it. This data is available to $IPB in the status reply packet that it receives from the LBU.

Operator commands for $IPB are provided through the CMI product, which is described in Appendix K of the Communications Management Interface (CMI) Operator's Guide.

SECTION 6

INTRODUCTION TO INFOSAT

NOTE

This product is available only on the Tandem NonStop II system. It cannot be used on the Tandem NonStop system.

This section introduces INFOSAT, Tandem's joint venture with American Satellite Company (ASC). INFOSAT is a fully integrated, computer/satellite network. You'll find information here about how satellites and earth stations work, and about the benefits of transmitting and receiving over satellite lines. In addition, this section describes many of the different components that make up the satellite, the earth station, and the Tandem NonStop II interface.

If you need to learn more about INFOSAT after reading this section, see Appendix L of the Communications Management Interface (CMI) Operator's Guide. It explains how to use CMI to access INFOSAT. The System Management Manual tells you how to configure an INFOSAT subnetwork into your EXPAND network. Finally, if you need to run on-line diagnostic functions on your INFOSAT system, read the Guide to the CMI Diagnostic Facility.

OVERVIEW

INFOSAT allows the EXPAND network to run on satellite channels instead of terrestrial lines as the communications medium. If you need to transfer data over long distances, an INFOSAT system provides the following benefits:

- Price/performance - Satellite channels can add a large amount of transmission capacity and significantly reduce the cost of long distance communications.

- Reliability - INFOSAT is fault tolerant; that is, there are two parallel "sides," or paths to the satellite. Hence, if a failure should occur, the data rate will degrade to only 56 kbps (from 112 kbps).

- Low error rate - The average error rate for INFOSAT is better than for terrestrial lines. This reduces the occurrence of retransmissions and results in better response time and throughput.

- Responsibility/Serviceability - There is a single source of responsibility and maintenance for all elements in the communications links. By integrating the earth station with a Tandem NonStop II computer, you can constantly monitor and diagnose the entire system. Many INFOSAT components are equipped with Field Replaceable Units (FRUs). If a FRU fails, a Tandem representative needs only the FRU number in order to replace the entire module.

- Availability - INFOSAT service can be provided anywhere in the continental U.S., whereas terrestrial high-speed digital circuits may have long service lead times or may not be available at all in some areas.

SATELLITES

A communications satellite is a relay station which receives, amplifies, and retransmits data signals from stations on earth (called, appropriately, earth stations).

Early satellites moved around the earth and could echo signals only as they passed over the serviced area. Earth stations needed to track these early satellites as they passed across the sky.

Today's communications satellites appear to be in a stationary orbit from the ground, providing 24-hour availability. This means that an antenna on an earth station can point toward a satellite without moving. How does this stationary orbit work?

The satellite must be the geosynchronous type, that is, it must travel at the same speed as the earth's rotation in a "geo-stationary" orbit. To maintain a geostationary orbit, the satellite orbits in a fixed position approximately 22,300 miles above the equator. At this position, the satellite rotates around the earth in exactly 24 hours. Since 1963, all communications satellites have been of the geosynchronous type.

Satellite Components

The satellite consists of the following components:

- Transponders, which receive, amplify, change the frequency of and retransmit signals from earth stations.
- Solar panels, storage batteries and power conditioners, which generate and store the power for the satellite.
- Position control thrusters, which adjust the satellite orbital position and altitude.
- A command and telemetry subsystem, which transmit data about the satellite to the earth station and receive commands from the earth station.
- An antenna, which receives and transmits signals.

Figure 6-1 illustrates how the components of the satellite work together. The solar panels generate power and pass it to the storage batteries and power conditioner. The power is then distributed to the transponders (receivers, frequency translators and transmitters), and the command/telemetry subsystem.

Meanwhile, signals received at the antenna are transmitted through the antenna subsystem to the receiver portion of the transponder. There, the signals are amplified and passed to the frequency translator where the frequency is changed from 6GHz to 4GHz (1 gigahertz (GHz) means 1000 million cycles per second). The signals then continue through the transmitter, where they are further amplified. Finally, the signals are returned to the antenna for broadcast. In essence, the satellite echoes back to earth the same data stream it receives, after amplifying it and changing its carrier frequency.

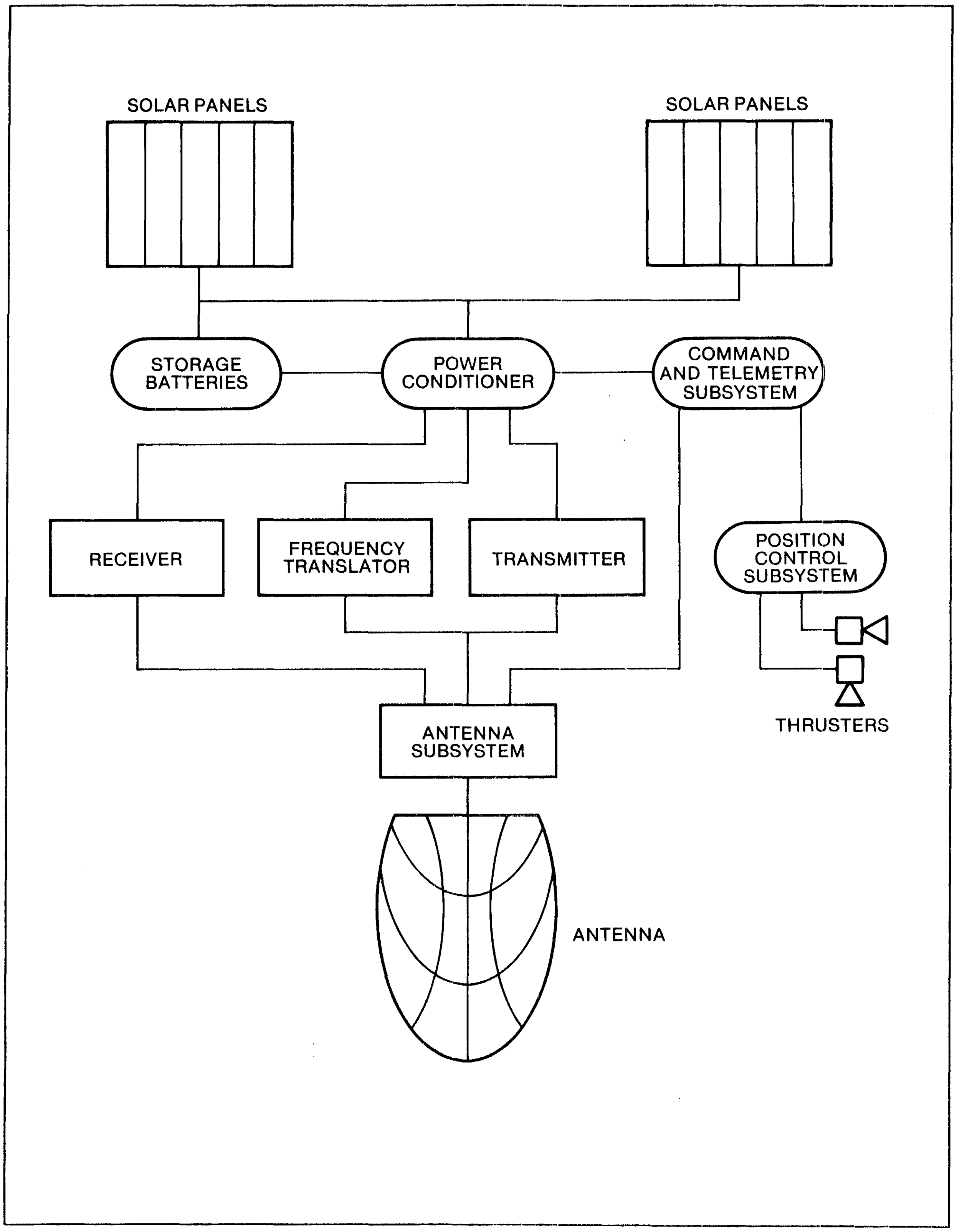


Figure 6-1. Satellite Components

Satellite Frequency Bands

Satellites operate in one or both of two frequency bands--Ku-band or C-band. The main difference between the two is that Ku-band operates at 14GHz for its uplink, 12 GHz for its downlink, while C-band operates at 6GHz for the uplink and 4GHz for the downlink. INFOSAT uses C-band for a number of reasons.

- C-band is not as susceptible to attenuation (weakening of the signal) during rainstorms.
- Components are simpler, less expensive, more reliable and more available for C-band.
- Antennas are less expensive because uniform surface tolerances are not as critical.

One drawback of C-band is that it is more subject to radio frequency (RF) congestion in metropolitan areas. INFOSAT addresses this problem by providing large, shared-use earth stations for customers who need it.

Footprint

Satellites broadcast signals over an area called a "footprint" (see Figure 6-2); the larger the footprint, the weaker the signal. There are several ways to compensate for weak signals, including larger earth station antennas, more powerful transmission amplifiers, or more sophisticated error correction techniques.

The satellite determines the shape of the footprint, concentrating the signal where it is needed, instead of broadcasting over too wide an area. INFOSAT's footprint covers the continental United States. Figure 6-2 illustrates the INFOSAT footprint. Note that areas located on the fringe of the footprint (southern Texas and Florida, Northern Maine and portions of some states bordering Canada) will receive a weaker signal than those toward the center and may therefore require a slightly larger earth station antenna to capture the signals.

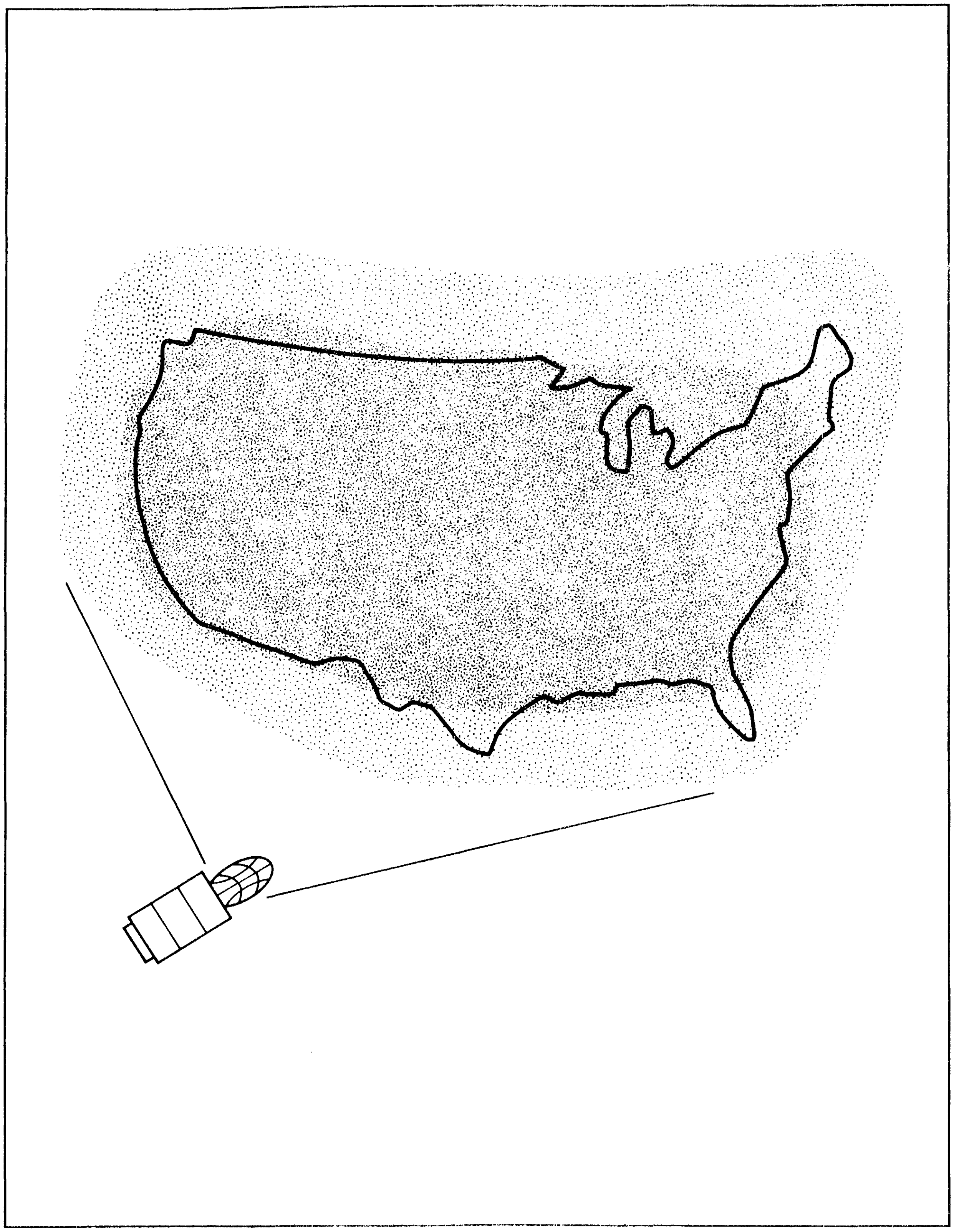


Figure 6-2. The INFOSAT Footprint

THE DEDICATED EARTH STATION

INFOSAT uses a dedicated, on-site earth station consisting of the following components:

- A 5-meter Cassegranian antenna (Cassegranian is a type of antenna which has easily accessible components for fast maintenance and repair).
- A feed horn located in the center of the dish.
- A four-port Ortho Mode Junction (OMJ). The INFOSAT earth station supports two separate, parallel signal paths. Each path can transmit and receive independently, thus providing for fault-tolerant operation and continuous availability. The signal paths are divided by the OMJ, mounted at the back of the feed horn. In all INFOSAT documentation, the paths are referred to as "horizontal" (#H) and "vertical" (#V), relating to their polarization of transmission from the earth station. Each path transmits signals through its own 56 kbps channel (for an aggregate bandwidth of 112 kbps for the earth station).
- Two radio frequency (RF) subassemblies mounted at the back of the antenna. The RF subassemblies house field replaceable units (FRUs) for easy maintenance and quick repair.
- Two intermediate frequency (IF) subassemblies mounted near the base of the antenna. The IF subassemblies also house FRUs.
- A power/cabling junction box.

Figure 6-3 illustrates how all of the earth station components fit together.

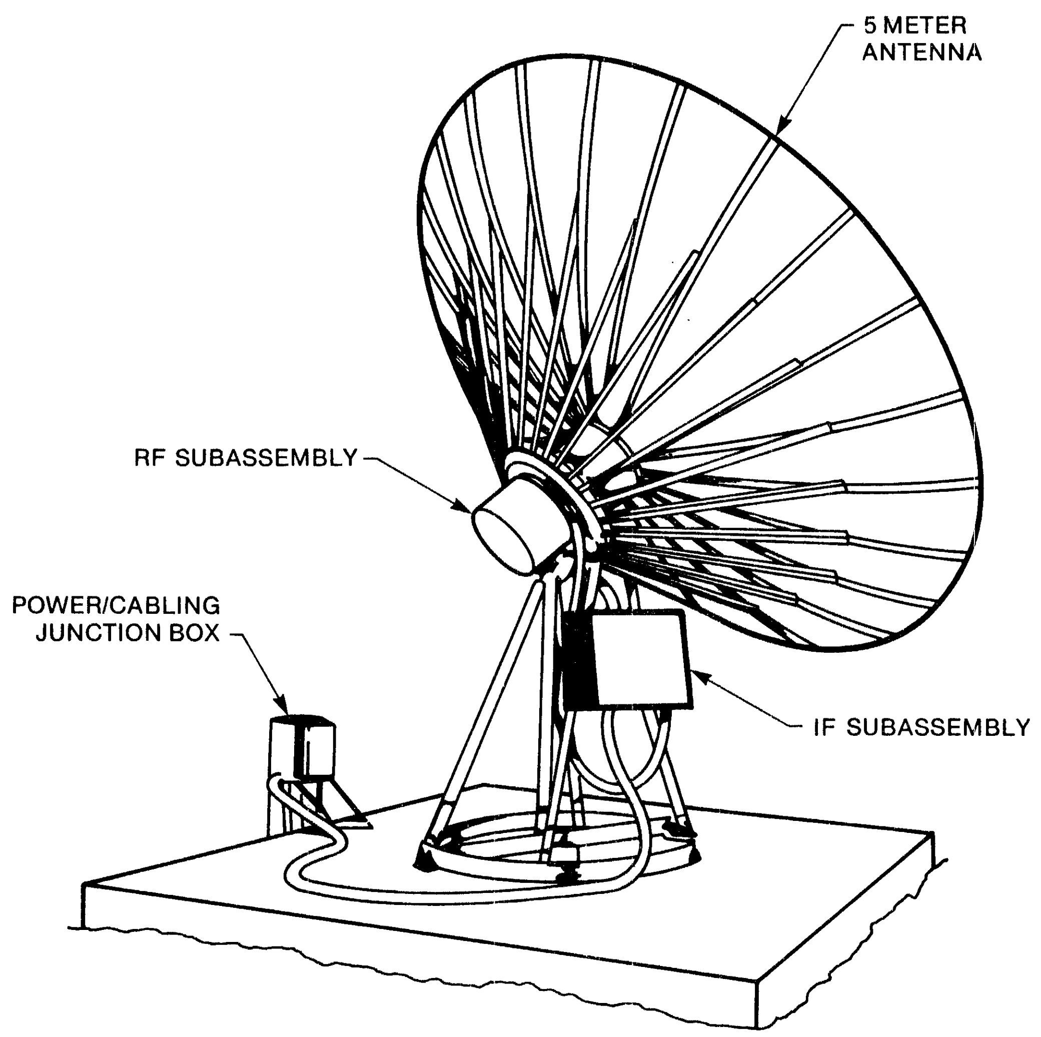


Figure 6-3. The INFOSAT Dedicated Earth Station

SHARED-USE EARTH STATIONS

If your facility is in a large, metropolitan area, it may not be feasible to install a dedicated earth station. Because of space limitations, RF congestion, or buildings or mountains that block signals, you may need a shared-use earth station. Currently, Tandem has use of ASC shared-use earth stations in New York, Chicago, Dallas, Los Angeles and San Francisco.

If you configure INFOSAT with a shared-use earth station, it is connected through two multiplexers (one for each of the parallel signal paths) to an ASC microwave dish station. The connection to ASC could be through terrestrial lines or microwave beams. Your broadcasts are transmitted via microwave to the shared-use earth station where the signals are converted for satellite transmission.

Computer Communication Interface Module (CCIM)

The dedicated earth station is connected to the Tandem NonStop II computer through a Tandem CCIM. The CCIM is located inside a building, not more than 1500 feet from the earth station. It also consists of two parallel sides (#H and #V). The CCIM contains several major components, including the Earth Station Controller (ESC), modulators, and demodulators. The ESC communicates with 6204 bit-synchronous controllers and on to the computer. Additionally, each CCIM contains the Diagnostic Monitoring System (DMS) which collects data from the modulators and demodulators and from outdoor data collectors. The CCIM houses FRUs for easy maintenance and quick repair.

INFOSAT SOFTWARE

The software required to complete the INFOSAT picture includes:

- The EXPAND product, including the Network Control Process and Line Handler

- The Satellite Link Manager (SLM)

- Diagnostic Programs

- The Tandem INFOSAT Control System (TICS)

You should be familiar with EXPAND and the Network Control Process. If you are not, go back and read Sections 1 through 4 of this manual.

The SLM provides for operational control of the INFOSAT earth station via the Communications Management Interface (CMI). The SLM process is responsible for all communications between the Tandem NonStop II computer and the earth station (except for

EXPAND data communications). Through CMI, the SLM performs all of the functions necessary to run and maintain an earth station. These functions include, but are not limited to:

- Control the earth station.
  - Download the ESC
  - Issue commands to the ESC (ENABLE, DISABLE, tuning)
  - Set error threshold values for the ESC
- Monitor the operation of the earth station.
  - retrieve status and statistics
- Run diagnostics on the earth station.

Appendix L of the Communications Management Interface (CMI) Operator's Guide describes the CMI commands you use for INFOSAT. The Guide to the CMI Diagnostic Facility provides information that will help you run on-line diagnostic tests and other functions to determine the exact point of failure if any component in your INFOSAT system fails to operate properly.

TICS is described later in this section.

Figure 6-4 shows the hardware and software relationship (minus TICS) from the satellite, through the earth station to the ESC and the Tandem NonStop II computer.

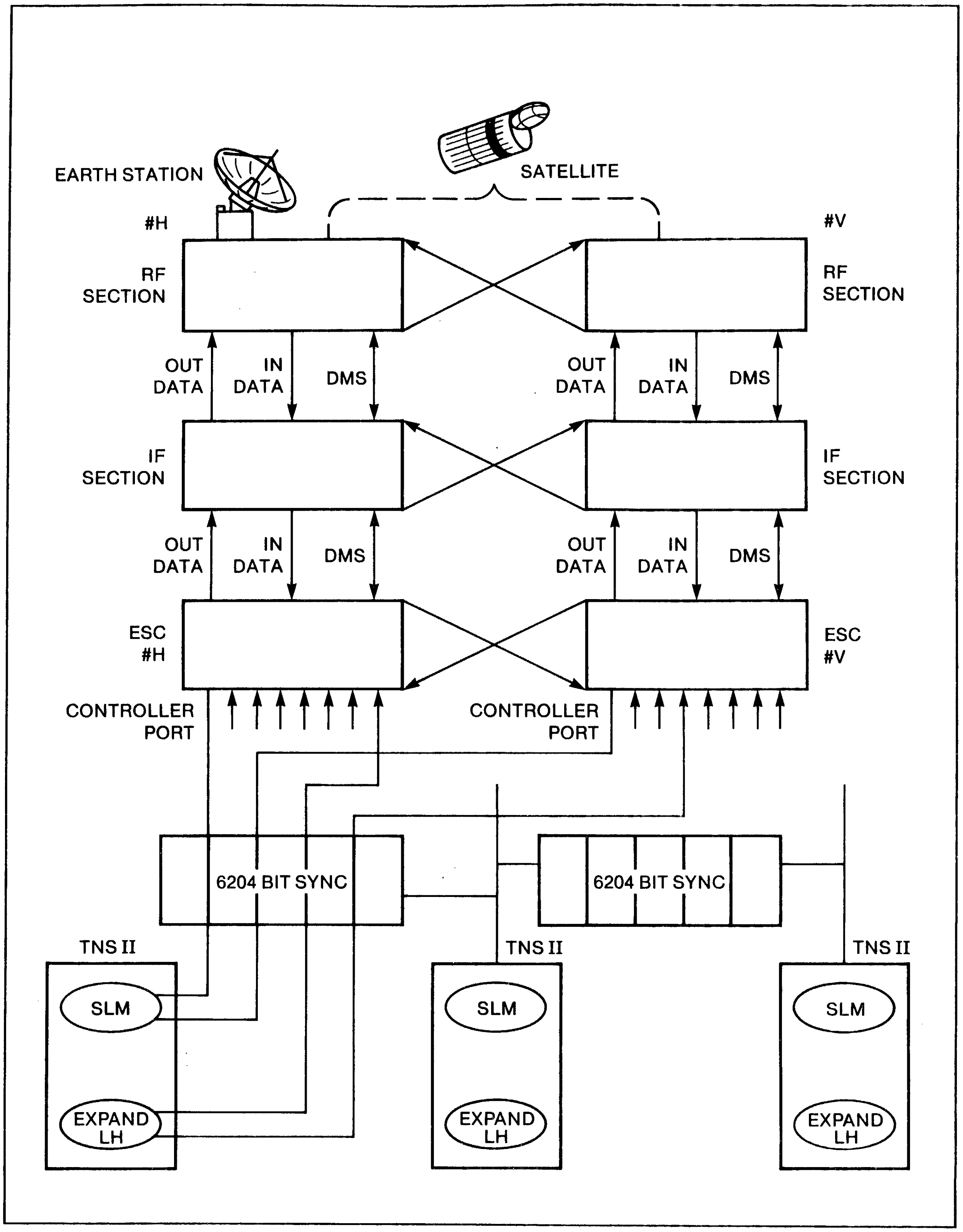


Figure 6-4. INFOSAT Hardware and Software

THE INFOSAT/EXPAND NETWORK

The basic INFOSAT configuration consists of two or more Tandem NonStop II systems with dedicated earth stations and transponder space on an orbiting satellite. This configuration fulfills the requirements for an integrated computer/satellite network that is fault-tolerant and continuously available.

An INFOSAT node can be included as a part of a larger EXPAND network. In this case, all nodes with the network are directly connected. Figure 6-5 illustrates this type of network configuration.

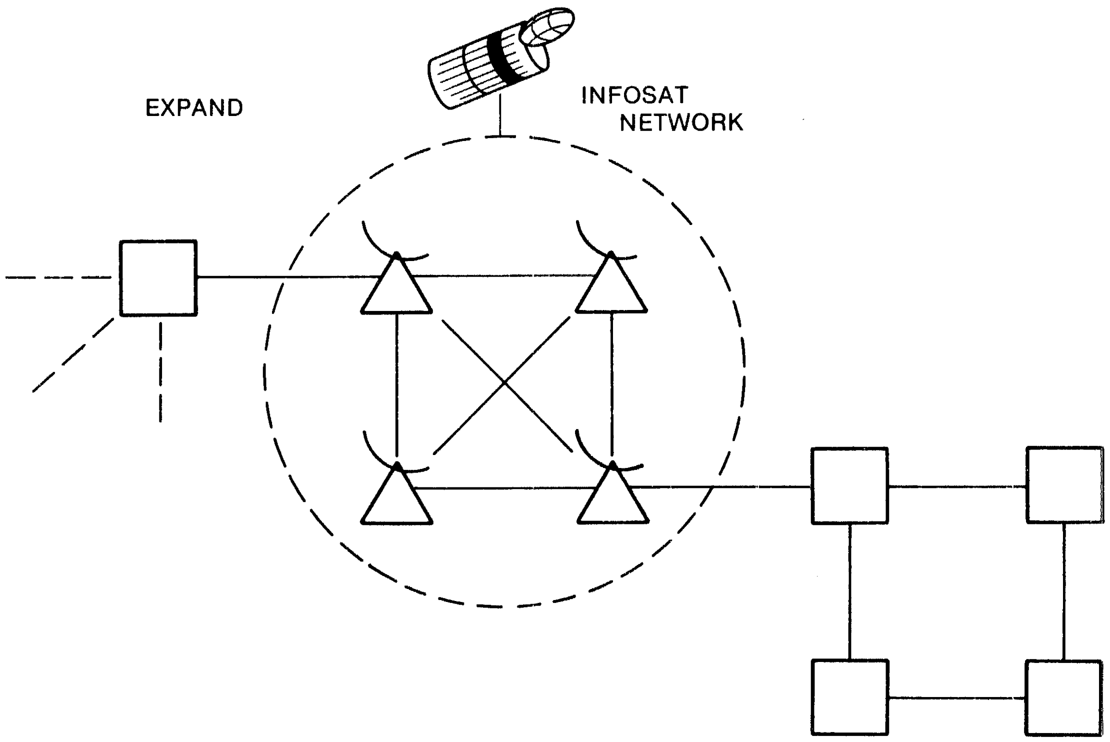


Figure 6-5. INFOSAT/EXPAND Network

Remember that the EXPAND network can support up to 255 nodes. With INFOSAT, each dedicated earth station can receive signals from up to seven other INFOSAT nodes. Conceivably then, all 255 nodes in an EXPAND network could be INFOSAT nodes, each able to receive signals from seven other INFOSAT nodes. If two nodes not directly connected to each other need to communicate, they can do so through standard EXPAND terrestrial lines, or they can pass data through a third INFOSAT node to which both are connected.

Figure 6-6 illustrates this type of connection. The "A" nodes on the left are all directly connected to each other and to node "B1" on the right. The "B" nodes on the right are all directly connected to each other and to node "A1" on the left. If node A5 needs to communicate with node B5, two "hops" are necessary; one satellite hop from node A5 to node B1 and a second hop from node B1 to node B5.

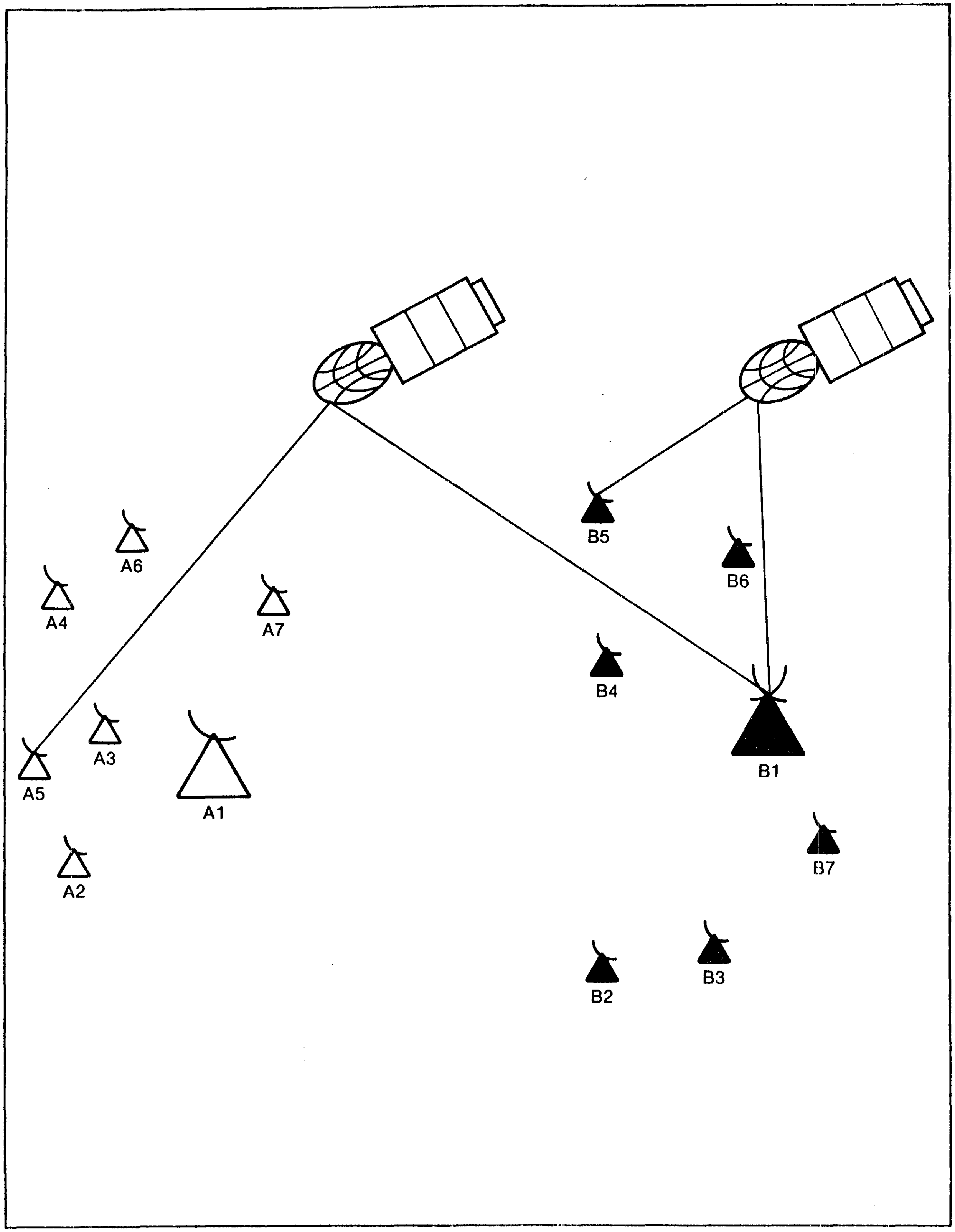


Figure 6-6. Satellite Hopping

TANDEM INFOSAT CONTROL SYSTEM (TICS)

Satellites are a broadcast medium. This means that anyone with an earth station and a parabolic dish can receive the broadcast. Therefore, the FCC has established stringent requirements on earth station broadcast parameters. Two requirements are of particular interest: First, all parameters must be established by FCC-licensed personnel and second, any earth station broadcasting out of tolerance must be shut down in a reasonable amount of time.

INFOSAT is constantly monitored by ASC's Network Operation Control Center (NOCC). Due to FCC regulations, it is necessary for the NOCC to have access to your Tandem NonStop II System. Note that the NOCC does not have access to your data base!

The NOCC can access your system through Tandem-operated software called the Tandem INFOSAT Control System (TICS). TICS provides a central control point for INFOSAT operation, and coordinates INFOSAT earth stations. TICS is an application program which allows FCC-licensed Tandem personnel to perform various operations on any INFOSAT earth station. TICS maintains a dial-up connection with all INFOSAT sites. In essence, TICS acts as an intermediary through which the NOCC monitors the performance of your system and insures that FCC regulations are adhered to.

The dial-in/dial-out capabilities of TICS perform the following functions:

- Handle asynchronous terminal dial-in ports for communications from NOCC, ASC, or a Tandem field engineer
- Authenticate the caller
- Turn on or turn off the transmitter
- Set transmit frequencies
- Set transmit power levels
- Establish station IDs
- Read an INFOSAT station's status and monitor data
- Execute diagnostics (limited)
- Maintain a telephone directory for customer dial-in ports
- Dial out to a customer upon command, authenticate the connection, and transfer commands and responses.
- Log actions for each INFOSAT system

Remember that the earth station can be taken down and brought up only by FCC-licensed personnel via TICS. Therefore, you must dial into TICS before taking any action which requires you to bring up or shut down a side of the earth station, or any action that requires a change in frequency or power levels.

Figure 6-7 shows how TICS and NOCC fit into the INFOSAT product, and completes the INFOSAT picture.

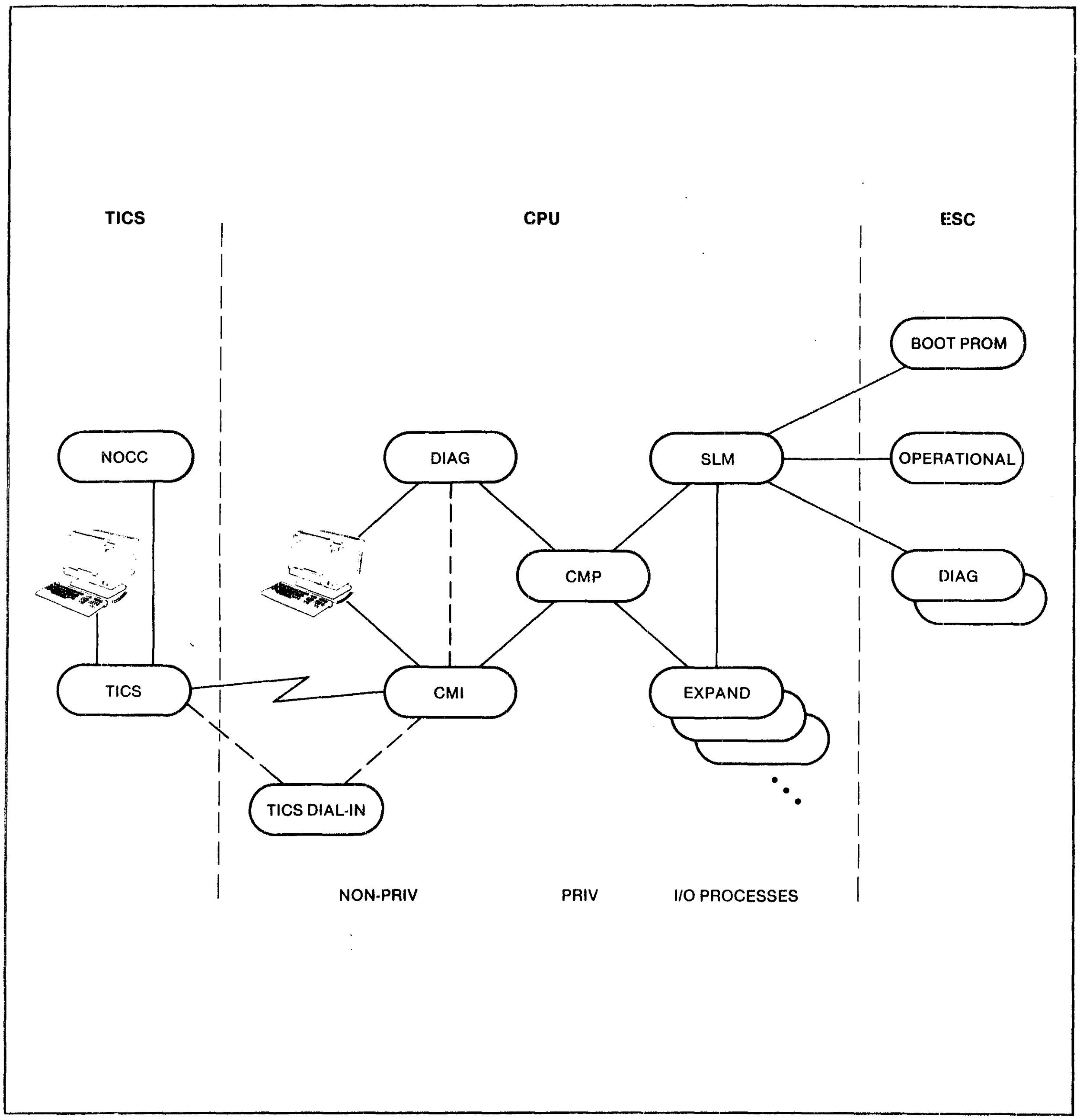


Figure 6-7. The INFOSAT Connection

APPENDIX A

CONSOLE MESSAGES

This appendix contains a summary of the network-related messages that the communications I/O process and Network Control Process (NCP) send to the operator console. This appendix also provides a brief explanation of how to interpret the file system error indication for a modem status error (140), I/O bus error (218), and not ready (248).

MESSAGE FORM

The general form of a console message is:

```
[msg no.]  [timestamp FROM sender system no.  sender cpu pin]
           message
```

where

msg no.

is a system message number; generated by the system as opposed to being generated by an application.

timestamp

is of the form: hour:minute   day   month   year

FROM sender system no.   sender cpu   pin

indicates the system number in the network, processor module, and processid in which the message originated.

⟶

message

is a message generated either by an application or the system.

NOTE

For the following message descriptions, entries for msg no., timestamp, FROM sender system no., sender cpu, and pin are represented by {...} rather than repeating them for each console message. The ldev and %ccu entries indicate the logical device number and controller/unit number of the device causing the message.

Driver Generated Messages

The communications driver sends five network-related messages (04, and 06 through 09) to the operator console:

```
04 {...} LDEV ldev [%ccu] ERROR dev status  param1  param2  BEL
```

Message 04 indicates that an error occurred on the reported device and the retry was unsuccessful. The entry for dev status contains the status returned by the device controller; param2 contains the file system error number.

BYTE SYNCHRONOUS CONTROLLER. The format of the dev status for the Byte Synchronous controller is:

WRITE UNIT	READ UNIT
.<0> = Power On	.<0> = Power On
.<1> = Channel Underrun	.<1> = Device Overrun
.<2> = Channel Abort	.<2> = Channel Abort
.<3> = Channel Parity Error	.<3> = unused
.<4> = Auto Poll Term.	.<4> = BCC Error
.<5> = Data Set Rdy Term.	.<5> = VRC Error
.<6> = Modem Loss	.<6> = Modem Loss
.<7> = Byte Cnt Term.	.<7> = Byte Cnt Term.

Modem Loss. If Modem Loss is detected, dev status.<6> = 1, or (on a Write Unit) if dev status.<5> = 1, bits.<8:15> have the following meanings:

WRITE UNIT	READ UNIT
.<8> = Data Set Rdy	.<8> = Data Set Rdy
.<9> = Modem Loss Sense	.<9> = Modem Loss Sense
.<10>= Data Carrier Detect	.<10>= Data Carrier Detect
.<11>= Clear To Send	.<11>= Clear To Send
.<12>= DSR Intrpt	.<12>= DSR Intrpt
.<13>= Ctrl Carrier Enable	.<13>= Ctrl Carrier Enable
.<14>= Request To Send	.<14>= Request To Send
.<15>= Data Terminal Rdy	.<15>= Data Terminal Rdy

No Modem Loss. If no Modem Loss is detected, dev status.<6> = 0, or (on a Write Unit) if dev status.<5> = 0, bits.<8:15> have the following meanings:

WRITE UNIT		READ UNIT	
.<8>	state count	.<8> = ETB/ETX sensed	
.<9>		.<9> = SOH/STX sensed	
.<10>		.<10>	state count
.<11>		.<11>	
.<12>		.<12>	
.<13>		.<13>	
.<14>		.<14>	
.<15>		.<15>	

BIT SYNCHRONOUS CONTROLLER. The format of the dev status for the Bit Synchronous controller is:

WRITE UNIT	READ UNIT
.<0> = Power On	.<0> = 0
.<1> = Channel Underrun	.<1> = Channel Underrun
.<2> = Channel Abort	.<2> = Channel Abort
.<3> = Channel Parity Error	.<3> = 0
.<4> = Modem Loss	.<4> = Modem Loss
.<5> = 0	.<5> = Read Byte Overrun
.<6> = Transmit Underrun	.<6> = Receiver Overrun
.<7> = No Encryption	.<7> = No Encryption

AUTOPOLL OPERATION	MODEM CONTROL OPERATION
.<0> = 0	.<0> = 0
.<1> = Channel Underrun	.<1> = 0
.<2> = Channel Abort	.<2> = 0
.<3> = Channel Parity Error	.<3> = 0
.<4> = Modem Loss	.<4> = 0
.<5> = Autopoll Terminated	.<5> = 0
.<6> = Transmit Underrun	.<6> = DSR Data Set Rdy Intrpt
.<7> = 0	.<7> = 0

Modem Loss. If Modem Loss is detected, dev status.<4> = 1, bits.<8:15> indicate the modem status for the write and read units, and the autopoll and modem control operations:

```
.<8> = DSR*  Data Set Rdy (invert)
.<9> = CD*  Carrier Detect (invert)
.<10>= CTS*  Clear To Send (invert)
.<11>= Transmit Overrun
.<12>= RS-422
.<13>= Maintenance mode
.<14>= RTS  Request To Send
.<15>= DTR  Data Terminal Rdy
```

No Modem Loss. If no Modem Loss is detected, dev status.<4> = 0, bits.<8:15> have the following meanings:

```
WRITE UNIT                READ UNIT

.<8>  ⎫                   .<8> = Receiver Error
.<9>  ⎪                   .<9> = ABC.<0>, Assembled Bit Cnt
.<10> ⎪                   .<10>= ABC.<1>
.<11> ⎬ Ending State      .<11>= ABC.<2>
.<12> ⎪   Count           .<12>= Receiver Overrun Error
.<13> ⎪                   .<13>= Abort/Go-Ahead char detect
.<14> ⎪                   .<14>= Receiver End-of-Message
.<15> ⎭                   .<15>= 0

AUTOPOLL OPERATION        MODEM CONTROL OPERATION

.<8> = 0                  .<8> = DSR*  Data Set Rdy (invert)
.<9> = 0                  .<9> = CD*  Carrier Detect (invert)
.<10>= 0                  .<10>= CTS*  Clr To Send (invert)
.<11>= 0                  .<11>= Transmit Overrun
.<12>= 0                  .<12>= RS-422
.<13>= 0                  .<13>= Maintenance mode
.<14>= End of Poll-List   .<14>= RTS  Request To Send
.<15>= End of Poll        .<15>= DTR  Data Terminal Rdy
```

06 {...} LDEV ldev [%ccu] UP

Message 06 indicates that the device has been placed online following a PUP UP command.

07 {...} LDEV ldev [%ccu] DOWN (BEL)

Message 07 indicates that the device has been placed offline following a PUP DOWN command.

```
08 {...} LDEV ldev [ %ccu ] STAT1   st1-f1   st1-f2   st1-f3

09 {...} LDEV ldev [ %ccu ] STAT2   st2-f1   st2-f2   st2-f3
```

Messages 08 and 09 report device statistical information. These statistics are reported if a line's error count exceeds its designated threshold value, or after a line is closed with a nonzero statistic value. The statistics message fields have the following meanings:

```
st1-f1 = number of messages sent
st1-f2 = number of messages received
st1-f3 = number of NAKS received
st2-f1 = number of BCC errors
st2-f2 = number of format errors
st2-f3 = number of retries
```

NCP Generated Messages

The Network Control Process (NCP) sends twelve network-related messages (33 through 35, 43 through 49, 91 and 92) to the operator console:

NOTE

Message numbers 43, 46, 48 and 49 may be enabled or disabled by use of the CUP ALTER command.

```
33 {...} LDEV ldev NET: LINE QUALITY ###
```

This message indicates that the line handler has reported a change in line quality (greater than or equal to five percent) to the NCP.

```
34 {...} NET: LOGGING AT SYS ###
```

Message 34 indicates the system, other than the local system, that the NCP sends the console log messages. See NETMON LOGCENTRAL command.

```
35 {...} NET: LOCAL LOGGING RESUMED
```

This message indicates that the NCP now sends the console log messages to the local system. See NETMON LOGCENTRAL command.

43 {...} LDEV ldev NET: CONNECTION LOST TO SYS ### (xxx) (BEL)

This message occurs for three reasons:

xxx = 1	The NCP has found all paths to system ### are unavailable.
xxx = 4	An end-to-end protocol error reported by the line handler. The NCP attempts reconnect through the same path; if unsuccessful, a reconnect through an alternate path is attempted.
xxx = 999	Recovery from soft failure; related to path timing.

```
44 {...} LDEV ldev   NET:   LINE READY
                     X25:
```

Message 44 indicates that the line handler is ready to accept network requests. For the Direct Connect line handler, line ready occurs after both line handlers (local and remote) have exchanged reset sequences. For the X.25 interface, line ready occurs after the line handler is informed of the establishment of a virtual circuit or learns of the circuit by querying the X.25 AXCESS process.

```
45 {...} LDEV ldev   NET:   LINE NOT READY, ERROR ###   (BEL)
                     X25:
```

Message 45 indicates existence of an error that the line handler cannot resolve through the normal retry mechanism. The line handler will not accept subsequent network requests, thus causing the NCP to attempt a reconnect through an alternate path. The error entry contains a file system error number that describes the condition that caused the message.

46 {...} LDEV ldev NET: CONNECTED TO SYS ###

This message indicates a successful connect exchange with the NCP at remote system ###

47 {...} LDEV ldev NET: LVL 4 TIMEOUT TO SYS ### (BEL)

This message indicates that the line handler failed to receive an end-to-end response within the configured timeout and retry values

48 {...} NET: SYS ### CPU STATUS pppppppppppppppp (BEL)

Message 48 indicates a change in processor status at system ### has occurred. The p entry indicates the up/down (1/0) state of the processors in the system; leftmost number is processor 0 and rightmost is processor 15.

49 {...} LDEV ldev NET: ### NOT RESPONDING (BEL)

Message 49 indicates that the NCP at the receiving system has not received a status message from the NCP at system ### for three time periods. The NCP looks for an alternate path.

91 {...} LDEV ldev NET: DEVICE SUBTYPE INVALID

This message occurs during system initialization time if ldev subtype is not equal to 0, 1, or 2. EXPAND will not run until the SYSGEN LDEV subtype is corrected.

92 {...} LDEV ldev NET: TOO MANY LINES GEN'D FOR THIS PATH

Message 92 occurs during system initialization time if ldev subtype is specified as one of the following: more than 1 path ldev, more than 1 path/line, or more than 8 line ldevs. EXPAND will not run until the SYSGEN configuration is corrected.

Fiber Optic Extension (FOX) Generated Messages

The following console messages support bus and path controls:

135 {...} path BUS SHUT DOWN TO CLUSTER cc, PROCESSOR pp

The indicated path has been taken out of service because too many errors have occurred in a ten-minute interval.

136 {...} path BUS ERRORS TO CLUSTER cc, PROCESSOR pp
#ttttt #wwwww

On the indicated path, messages to the cluster and processor indicated have encountered <u>ttttt</u> SEND instruction timeouts and/or <u>wwwww</u> WACK (waiting for acknowledgement) timeouts.

137 {...} X BUS ERRORS FROM CLUSTER cc, PROCESSOR pp
#ccccc #rrrrr

On the X bus, messages from the indicated cluster and processor have caused <u>ccccc</u> checksum errors and <u>rrrrr</u> routing errors.

138 {...} Y BUS ERRORS FROM CLUSTER cc, PROCESSOR pp
#ccccc #rrrrr

On the Y bus, messages from the indicated cluster and processor have caused ccccc checksum errors and rrrrr routing errors.

139 {...} BUS SEQ ERRORS FROM CLUSTER cc, PROCESSOR pp
#sssss #uuuuu

Messages from the indicated cluster and processor have caused sssss sequence errors and uuuuu unexpected packet interrupts.

140 {...} CAN'T ALLOCATE RECEIVER'S LCB FOR CLUSTER cc,
PROCESS ID pp,ppp

This message occurs when allocation fails for the LCB for the receiver of a message from the indicated cluster and process.

The following console messages support LBU status control:

166 {...} LDEV $nn LBU x NO RESPONSE TO STATUS POLL

Special function packets responding to status requests are not being received from the LBU. If the LBU was powered off, this is normal; otherwise it indicates a failure of the LBU. The LBU CPB LED display should be checked.

167 {...} LDEV $nn LBU x RESET HAS OCCURRED

The controller entered the LCS UNLOADED state while it was in the normal operational state. This is normal if power is lost and then returned. Automatic reload of LCS will occur.

168 {...} LDEV $nn LBU x STANDARD MICROCODE LOADED

The LCS loading procedure has completed. The controller is now operational.

169 {...} LDEV $nn LBU x LOAD FAILED - FILE fff,
FLAGS %nnnnnn, STATUS %ooo, RESET %rrr, MCERR mmm

An attempt to load the controller failed. If file access errors occurred on the microcode file, fff is the file system error code. If the firmware was loaded and a status packet was received, nnnnnn and ooo are the FLAGS and STATUS CODE fields of the status packet. The RESET CODE rrr is the reason supplied by the boot PROM reset reason code if applicable. The LBU flags are described under "STATUS LBU" in Appendix K of the CMI Operator's Guide. See Status and Reset Codes, below, for status and reset code definition. The code in MCERR is returned by the standard microcode utility procedures. An MCERR not equal to zero indicates a mismatch between the hardware part number and revision level, and the data in the microcode file.

170 {...} LDEV $nn LBU x WCS LOAD FOUND ACCEPTABLE

Upon initialization, the $IPB process found that the controller already contained the correct version of the operational firmware. The controller was not reloaded.

171 {...} LDEV $nn LBU x CONTROLLER FAILED - RESET %rrr,
FLAGS %nnnnnn, STATUS %ooo

The controller entered the error state. nnnnnn and ooo and rrr have the same meanings as described above. See Status and Reset Codes, below, for status and reset code definition.

172 {...} LDEV $nn LBU x EXCESSIVE ERRORS OCCURRING

Internal error counters maintained by the controller are being incremented at a rate faster than a preset threshold. The LBU STATUS display of CMI should be examined to determine the cause; use "CMI STATUS LBU UNDER $IPB, DETAIL".

173 {...} LDEV $nn PATH TO CLUSTER cc MAY HAVE FAILED -
CHECK SUBNET STATUS

A discrepancy between sent and received handshake packets was detected. Use CMI to examine the SUBNET status and determine the specific details. One or more of the four redundant paths to or from the specified cluster may have failed.

174 {...} LDEV $nn IPB MONITOR FAILURE SYNDROME aaaaa bbbbb

The IPB monitor process has detected a condition that prevents further processing. Any subsequent requests to the IPBMON process will be rejected with file system error 66. The syndrome fields should be examined to ascertain the reason for the failure.

The following codes are assigned:

00001 00000	The special function packet interface to the operating system could not be initialized. (Occurs when $IPB is on a non-FOX system.)
00002 00000	The IPB monitor was generated with a number of units not equal to one.
00003 00000	Memory could not be locked for the monitor process special function packet interface.

All of the above conditions can occur only immediately after the loading of the processor containing the IPB monitor process.

STATUS AND RESET CODES

Possible STATUS CODE indications in the LBU STATUS display are:

%000 SELFTEST PASSED - READY TO LOAD

%000 SELFTEST PASSED - SLB NOT READY

%001 LOADING

%002 LOADED - READY TO EXECUTE

%003 EXECUTING

%004 EXECUTING DIAGNOSTIC

%265 EXT SELFTEST FAILED - SLB PARITY DETECTOR

%266 EXT SELFTEST FAILED - SLB STATUS REGISTER 2

%267 EXT SELFTEST FAILED - SLB NOVRAM

%270 EXT SELFTEST FAILED - SLB LOOPBACK

%271 EXT SELFTEST FAILED - SLB INITIALIZATION

%272 EXT SELFTEST FAILED - CPB/SLB INTERFACE

%273 EXT SELFTEST FAILED - IPC NOVRAM

%274 EXT SELFTEST FAILED - IPC BUFFER MEMORY

%275 EXT SELFTEST FAILED - IPC INTERVAL TIMER

%276 EXT SELFTEST FAILED - CPB NOVRAM

%277 EXT SELFTEST FAILED - CPB PRIORITY ENCODER

%357 SELFTEST FAILED - IPC FUSE

Possible RESET CODE indications and meanings are:

%000 RESET BY PON OR PANEL RESET SWITCH

The LBU was reset due to the CPB or IPC power cycling or by the CPB panel reset switch being pressed.

%020 RESET DUE TO IPC OUTQ PARITY ERROR

An IPC OUTQ parity error occurred during normal operations. Most likely cause is a faulty IPC OUTQ memory.

%021 RESET DUE TO CPB/SLB SBUS STATUS PARITY ERROR

A parity error was detected while reading SLB status. Most likely cause is a faulty SLB.

%022 RESET DUE TO CPB/SLB SBUS ADDRESS PARITY ERROR

A parity error was detected on the SADDR bus. Most likely cause is a faulty CPB.

%023 RESET DUE TO SLB NOT READY

The SLB went to the not ready state during normal operations. Most likely cause is that the SLB power is off.

%024 RESET DUE TO CPB PRIORITY ENCODER ERROR

The most likely cause is a faulty CPB.

%025 RESET DUE TO INTERMITTENT CLUSTER ID

The last read cluster ID does not match a previously read value. Most likely cause is a faulty CPB, the backplane cluster ID jumpers, or the backplane. (Any of these faults may also cause the physical state to be NO RESPONSE. The cluster ID read by the CPB microprocessor may be displayed in the CPB LED display by setting switch 7 on the CPB while the LBU is in the unloaded (STOPPED) state.)

%026 RESET DUE TO CPB STUCK PARITY ERROR

A buffer memory or SLB parity error indication persisted following a command to clear parity errors. Most likely cause is a faulty CPB.

%027 RESET DUE TO INVALID CLUSTER ID

The cluster ID read during the operational microcode initialization was 0 or 15. See status code %025.

%070 INTERNAL CONSISTENCY CHECK FAILED - IPC IQSTAT SETTING

The IPC IQSTAT for a destination does not agree with the destination queue packet count. Most likely cause is a faulty IPC or invalid control structure data in CPB fast memory.

%071 INTERNAL CONSISTENCY CHECK FAILED - CONTROL STRUCTURE

The local cluster destination stopped flag has been reset. Most likely cause is invalid control structure data in CPB fast memory.

%072 INTERNAL CONSISTENCY CHECK FAILED - CONTROL STRUCTURE

The packets pending flag for a destination does not agree with the destination queue packet count. Most likely cause is invalid control structure data in CPB fast memory.

%073 INTERNAL CONSISTENCY CHECK FAILED - OUTGOING FRAME

An outgoing data frame was addressed to cluster 0 or 15. Most likely cause is invalid control structure data in CPB fast memory or a failure of the CPB priority encoder.

%074 INTERNAL CONSISTENCY CHECK FAILED - CONTROL STRUCTURE

A constant value stored in CPB fast memory has changed.

%075 INTERNAL CONSISTENCY CHECK FAILED - CONTROL STRUCTURE

The head/tail pointers for a destination queue do not agree with the destination queue packet count. Most likely cause is invalid control structure data in CPB fast memory.

%076 INTERNAL CONSISTENCY CHECK FAILED - CONTROL STRUCTURE

Start/stop status of a destination does not agree with the destination queue packet count. Most likely cause is invalid control structure data in CPB fast memory.

%077 INTERNAL CONSISTENCY CHECK FAILED - OUTGOING FRAME

An outgoing data frame was formatted as a control-only frame. Most likely cause is invalid control structure data in CPB fast memory.

%370 RESET BY HOST WHILE IN UNLOADED STATE

The IPB Monitor issued a reset command while the LBU was in the unloaded state. Most likely cause is an operator-issued STOP or ABORT command.

%371 RESET BY HOST WHILE IN LOADING STATE

The IPB Monitor issued a reset command while the LBU was in the loading state. Most likely cause is a download error (the download failed to complete successfully).

%372 RESET BY HOST WHILE IN LOADED STATE

The IPB Monitor issued a reset command while the LBU was in the loaded state. Most likely cause is a download error (the download failed to complete successfully) or the SLB was not ready.

%373 RESET BY HOST WHILE IN OPERATIONAL STATE

The IPB Monitor issued a reset command while the LBU was in the operational state. Most likely cause is an operator-issued STOP or ABORT command.

%374 RESET BY HOST WHILE IN DIAGNOSTIC STATE

The IPB Monitor issued a reset command while the LBU was in the diagnostic state. Most likely cause is that the diagnostic status indicated a fault in the LBU or the diagnostic failed to respond to a status request in the allowed time.

NETWORK LINE-ERROR DIAGNOSIS

The following discussion provides a brief explanation of how to interpret the file system error indication for a modem status error (140), I/O bus error (218), and not ready (248). It is intended to aid in the diagnosis of line problems within the network.

Modem Status Error (140)

The Network Line Handler reports modem errors for these reasons:

- Data Set Ready (DSR) not detected within 30 seconds.
- DSR lost.
- Carrier Detect (CD) lost.
- Clear to Send (CTS) lost.

Any of the above conditions cause a modem status error indicated by a file system error (140) or console message (04). In the case of the console message, interpretation of the dev status bits depends on whether a byte synchronous or bit synchronous controller is being used.

For the Byte Synchronous controller, dev status.<13:15> indicate the reason for the modem status error.

dev status.<13> = Carrier Detect

dev status.<14> = Clear to Send

dev status.<15> = Data Set Ready

For the Bit Synchronous controller, dev status.<8:10> indicate the reason for the modem status error.

dev status.<8> = DSR*, Data Set Ready (invert)

dev status.<9> = CD*, Carrier Detect (invert)

dev status.<10> = CTS*, Clear To Send (invert)

I/O Bus Error (218)

The Network Line Handler reports 218 errors when a write interrupt does not occur within the level-2 time period. This error may indicate a controller problem but also occurs if the modem is not generating transmit-clock pulses.

Not Ready (248)

The Network Line Handler reports error 248 when unable to establish level-2 communications or when all level-2 retries have been exhausted. Possible reasons for this error are:

- the other system is down. If an alternate path exists, the state of the other system can be determined by issuing a NETMON MAPS command.
- incorrect NEXTSYS parameters. This error occurs only on the initial connection but should not occur after that.
- garbled or no data in/out. By performing successive CUP STATS commands (one-minute interval) and observing the U-FRAME counts, it can be determined whether data is being transmitted and received. The BCC error count indicates the presence of garbled receive data.

If the CUP STATS commands do not indicate both send and receive data, place the local modem in analog loopback and observe the U-FRAME counts again. If both send and receive counts are incrementing, the local controller and modem are okay. If both systems check out, check the lines by first using the modem self-test, then observe the U-FRAME counts with the remote modem in digital loopback. If all tests indicate data is being transmitted and received, then a trace at both ends of the line should indicate the cause of the not ready condition.

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