

**Systems**

**Introduction to VTAM**

**Virtual Telecommunications  
Access Method (VTAM)**

**IBM**

#### **Fourth Edition (August 1975)**

This edition applies to VTAM Level 2 when available in DOS/VS, OS/VS1, and OS/VS2. Until VTAM Level 2 is available in an operating system, the information in this publication is for planning purposes and is subject to change. VTAM Level 2 includes support for switched SDLC links, local 3790 attachment, and the SDLC 3270, 3650, 3660, 3770, and System/32. For VTAM Level 2 users, this edition replaces the previous edition, GC27-6987-3. Changes will be reported in subsequent revisions or Technical Newsletters.

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A form has been provided at the back of this publication for readers' comments. If this form has been removed, address comments to: IBM Corporation, Dept. 63T, Neighborhood Road, Kingston, New York 12401.

## PREFACE

This publication describes generally the services provided by the Virtual Telecommunications Access Method (VTAM). It is directed primarily to data processing managers who need a brief overview of VTAM as a component of Systems Network Architecture (SNA). Those needing a more detailed overview are referred to *VTAM Concepts and Planning*, GC27-6998.

VTAM operates under three virtual storage operating systems—DOS/VS, OS/VS1, and OS/VS2. It enables application programs to transfer data to and from terminals that are part of a telecommunication network.

Major topics are:

- Definition of a VTAM network
- Operation of the network
- VTAM macro instructions
- Operation of TCAM programs with VTAM
- VTAM reliability, availability, and serviceability features

In addition, Chapters 1 and 2 introduce the reader to the major features and concepts of VTAM. These chapters will be particularly useful to customer personnel seeking information on VTAM. The rest of the book provides preliminary information for installation managers and system programmers who are evaluating and planning for VTAM.

The reader should be familiar with basic teleprocessing concepts. These may be found in *Introduction to Data Communications Systems*, SR20-4461. Figure P-1 shows the reading order of VTAM publications for different user needs.

Throughout the book, where a particular function applies to OS/VS1 and OS/VS2, these systems are referred to jointly as OS/VS.

**General Information**

Introduction to VTAM,  
GC27-6987

or

VTAM Concepts  
and Planning,  
GC27-6998

Depending on how much  
information is required

**Planning and Installing VTAM**

VTAM Concepts  
and Planning,  
GC27-6998

VTAM System  
Programmer's Guide

DOS/VS GC27-6957  
OS/VS1 GC27-6996  
OS/VS2 GC28-0688

**Writing VTAM Application Programs**

VTAM Concepts  
and Planning,  
GC27-6998

Optional

VTAM Macro  
Language Reference,  
GC27-6995

and

VTAM Macro  
Language Guide,  
GC27-6994

and

VTAM  
Reference Summary

Reference Card

Optional

DOS/VS GX27-0033  
OS/VS GX27-0034

**Operating VTAM**

VTAM Network  
Operating Procedures

DOS/VS GC27-0025  
OS/VS GC27-0027

**Testing VTAM Resources Online**

DOS/VS and OS/VS  
TOLTEP for VTAM,  
GC28-0663

**Analyzing/Maintaining VTAM**

Introduction to  
VTAM Logic  
SY27-7256

VTAM Logic

DOS/VS SY27-7262  
OS/VS1 SY27-7257  
OS/VS2 SY28-0621

VTAM  
Debugging  
Guide

DOS/VS GC27-0021  
OS/VS1 GC27-0022  
OS/VS2 GC27-0023

VTAM Data Areas

DOS/VS SY27-7265  
OS/VS1 SY27-7266  
OS/VS2 SY27-7267

Control Block  
Overview

DOS/VS GX27-0029  
OS/VS1 GX27-0030  
OS/VS2 GX27-0031

Figure P-1. The VTAM Publications Plan

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*Summary of Changes  
for Fourth Edition*

The following changes have been made to this edition:

- VTAM is described as a component of IBM's System Network Architecture (SNA). The relationship between SNA and VTAM is briefly explained in Chapter 1.
- VTAM support for certain SNA terminals on switched (dial) SDLC links is described. An application program need not be aware of whether a terminal is on nonswitched or switched lines or locally attached.
- Support for terminal-entered LOGON and LOGOFF commands and Initiate-Self and Terminate-Self commands is described.
- Support for application program and terminal specified session parameters is described.
- Support for the following new IBM terminal products is included.
  - IBM 3270 Information Display System (adapted for SNA)
  - IBM 3660 Supermarket System
  - IBM 3767 Communication Terminal
  - IBM 3770 Data Communication System
  - IBM System/32 Batch Work Station

In addition, the 3650 Retail Store System and the 3790 Communication System, already supported on nonswitched lines, are now supported on switched lines, and the 3790 Communication System is now supported for local channel attachment.

- Chapter 3, "Creating a VTAM Telecommunication System," has a reorganized description of how to create the VTAM system.
- Appendix A has been reorganized to reflect the distinction between SNA terminals and local 3270, BSC, and start-stop terminals.

In addition to the major changes listed above, some sections have been expanded or reorganized.

***Summary of Changes  
for Third Edition***

The third edition:

- Added the requirements for using the CTRLPROG macro instruction when including VTAM in an OS/VS2 system.
- Changed the restrictions mentioned for the use of TCAM together with VTAM.
- Changed the list of supported devices (Appendix A).



## CHAPTER 1. INTRODUCTION

The Virtual Telecommunications Access Method (VTAM) is a component of System Network Architecture (SNA). SNA is an integrated structure that identifies and isolates network functions, and:

- Provides a consistent and comprehensive structure for telecommunications system growth
- Minimizes the effects of system changes
- Distributes network functions away from the host processor
- Allows sharing of network resources
- Provides a telecommunications environment that supports many different kinds of telecommunication devices
- Extends system functions conveniently and effectively to the user
- Minimizes the user's involvement in details of system operation

VTAM manages the SNA network. It directs transmission of data between VTAM application programs in the central computer and components of the telecommunication network. Because VTAM operates with the IBM 3704 and 3705 Communications Controllers, communication lines and communications controllers need not be considered in coding application programs.

Basic services performed by VTAM include:

- Establishing, controlling, and terminating access between the application programs and the terminals
- Moving data between application programs and the terminals
- Permitting application programs to share communication lines, communications controllers, and telecommunication terminals
- Permitting the telecommunication network to be monitored and altered
- Permitting the configuration of the telecommunication network to be changed while the network is being used

### Telecommunications Base

VTAM complements advanced hardware and software, including System/370 virtual storage, the IBM 3704 and 3705 Communications Controllers, DOS/VS, OS/VS1, OS/VS2, and the IBM Virtual Storage Access Method (VSAM). In addition to its primary role of data transmission, VTAM has features that establish it as a base for building telecommunication systems of any size, from small to large. Those features are:

- Sharing of network resources, which reduces line costs and makes the network more efficient
- Distribution of network control functions which can reduce the processing load on the host CPU
- Concurrent execution of TCAM and VTAM application programs using the same telecommunication network
- Services required for interactive applications (online inquiries and updates)
- Operation with the IBM 3704 and 3705 Communications Controllers to reduce the number of functions performed in the central computer for remote terminals
- Support for SDLC networks that use either nonswitched or switched lines, or both

- Support for local attachment of the IBM 3790 Communication System and the IBM 3270 Information Display System
- Reconfiguration of the network without regenerating the system
- Modular design for tailoring to user needs
- Support of many different terminals which use different line disciplines (start-stop, binary synchronous communication (BSC), and synchronous data link control (SDLC))
- Support of IBM industry-oriented and general purpose products, such as the IBM 3600 Finance Communication System and the IBM 3790 Communication System
- Support for remotely attached central processing units (CPUs) using BSC links
- Reliability, availability, and serviceability aids to assist in maintenance

## **System Requirements for Using VTAM**

VTAM is a component of the DOS/VS, OS/VS1, and OS/VS2 operating systems.

The instruction set must include the Compare and Swap and Compare Double and Swap instructions, a hardware feature available on System/370 central processing units. DOS/VS systems must have DOS multiprogramming support. Appendix A contains a list of devices that can be used with VTAM.

## CHAPTER 2. CHARACTERISTICS OF VTAM

Telecommunications is the process of transmitting data over long-distance communication facilities such as telephone lines. In a computer-based telecommunication system, data is passed between an application program in the computer and telecommunication devices connected to form a network. In the network, the remote devices are usually terminals that allow persons working at them to interact with the central computer. In a VTAM network, a terminal is an endpoint in relation to VTAM. An endpoint can be logic associated with a terminal subsystem or a stand-alone terminal or it can be a local 3270, BSC, or start-stop terminal. In this manual, all of these endpoints are referred to as *terminals* unless a distinction is required for clarity.

VTAM controls the flow of data between application programs in the central computer and terminals in the telecommunication network. Application programs use VTAM to communicate with the terminals; the terminals respond through VTAM. This chapter describes the composition of a telecommunication network and the way in which the parts of the network are controlled and shared through VTAM.

### Telecommunication Network

A telecommunication network consists of:

- Remote communication terminals and the lines that connect them to one another and to a central computer
- Local communication terminals attached by channels to the central computer.

A VTAM telecommunication network can consist of:

- IBM 3270 Information Display Systems and IBM 3790 Communication Systems attached locally (by channels) to the CPU
- IBM 3704 and 3705 Communications Controllers attached locally (by channels) to the CPU. (If only local 3270 and 3790 configurations are to be supported, a communications controller is not required.)
- IBM 3704 and 3705 Communications Controllers attached remotely (through a locally attached 3704 or 3705 Communications Controller) to the CPU
- IBM 3600 Finance Communication Systems, 3650 Retail Store Systems, 3660 Supermarket Systems, 3770 Data Communication Systems, and 3790 Communication Systems through a local or remote 3704 or 3705 Communications Controller
- IBM 3767 Communication Terminals and System/32 Batch Work Stations attached through a local or remote 3704 or 3705 Communications Controller
- IBM 3270 Information Display Systems on BSC or SDLC lines attached through a local or remote 3704 or 3705 Communication Controller
- Certain BSC and start-stop telecommunication terminals and remote computers attached by lines to a local or remote 3704 or 3705 Communications Controller

Appendix A contains a complete list of terminal products supported by VTAM.

Figure 2-1 illustrates a telecommunication network controlled by VTAM.

Two characteristics of the VTAM network are of primary importance:

- VTAM uses processing capabilities of the programmable communications controllers (3704 and 3705) and SNA terminals, allowing part of the telecommunication processing to be moved out of the central computer and into the network.

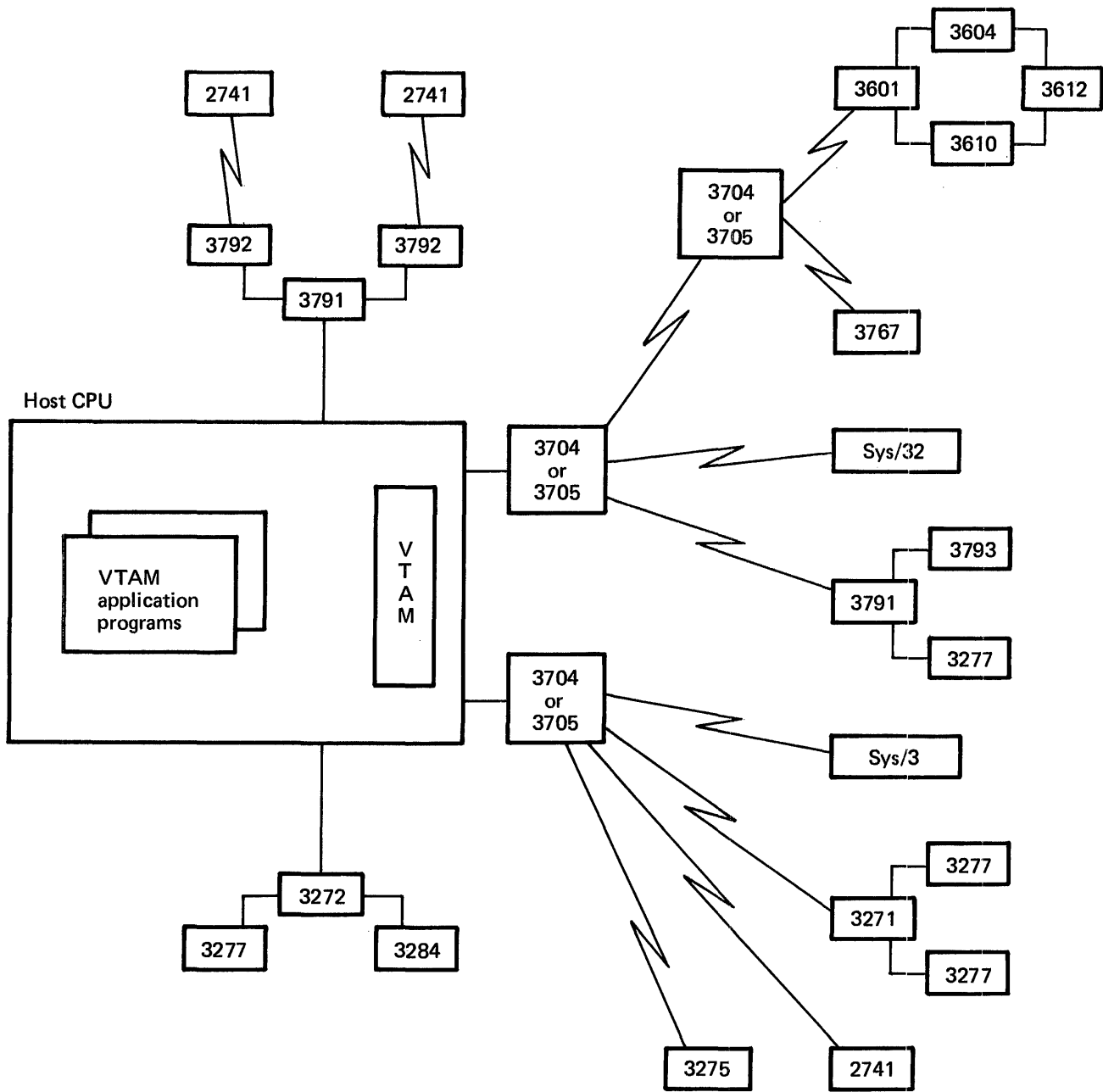


Figure 2-1. A VTAM Telecommunication Network

- VTAM treats the parts of the network as shareable resources. The lines, controllers, and terminals can be shared by all the application programs that use VTAM.

**Communications  
Controllers**

The IBM 3704 and 3705 Communications Controllers link VTAM with the remote portions of the network and control the flow of information between terminals and VTAM.

A single communications controller can support up to 352 telecommunication lines using a single subchannel address. Thus, the communications controllers permit large network configurations which require few subchannel addresses. The 3705 can be attached to either a byte-multiplexer channel, a block-multiplexer channel, or a selector channel, while the 3704 is attached to a byte-multiplexer channel.

A communications controller and its Network Control Program (NCP) support a variety of remote terminals attached to the controller. The NCP is generated from a series of user-specified macro instructions. An NCP can be generated to handle lines in either *network control mode*, or *emulation mode*, or both. An NCP that is generated with both kinds of functions is called an NCP with the Partitioned Emulation Programming (PEP) extension.

VTAM supports only the *network control mode*, either with or without PEP. (*Emulation mode* is used to emulate the IBM 2701 Data Adapter Unit and the IBM 2702 and 2703 Transmission Control Units and is not supported by VTAM.) In network control mode, the NCP allows some functions previously performed entirely by the access method to be performed primarily in the controller. Functions provided by a 3704 or 3705 include:

- Controlling lines
- Controlling dynamic buffering
- Deleting and inserting line control characters
- Detecting permanent line errors
- Gathering line statistics
- Activating and deactivating lines
- Closing down the network
- Handling recoverable line errors
- Providing error statistics to VTAM

Additional functions provided for start-stop and BSC terminals include:

- Translating character codes
- Date- and time-stamping

### ***Terminals in a VTAM Network***

Systems Network Architecture (SNA) defines functions that must be performed by the components of an SNA telecommunication network. *SNA terminal products* provide the terminal processing functions required by SNA. In addition, some types of SNA terminal products can process application programs without communicating with the host processor. Most access methods communicate with hardware in non-SNA terminals; VTAM communicates with logic in SNA terminals. SNA terminal logic consists of a *physical unit* (PU) and one or more *logical units* (LUs). The physical unit controls the interaction of the terminal with the rest of the network. The logical unit controls communication with VTAM application programs (through VTAM). An SNA terminal can have only one physical unit but can have one or more logical units, depending on the type of product. For example, a 3767 Communication Terminal has one logical unit while a 3600 Finance Communication System can have more than one logical unit. Since the functions performed by the logical units and physical units are common to all logical units and physical units in the system, VTAM can communicate with any physical unit or logical unit without regard to the type of SNA terminal product in which it resides.

Each logical unit in an SNA terminal product functions separately. Therefore, an SNA terminal product can function as more than one terminal. For example, a 3790 Communication System with three logical units functions as three terminals. Each of the three logical units can initiate connection and disconnection, and communicate with application programs independently.

VTAM supports both SNA terminals and local 3270, BSC, and start-stop terminals. Local 3270, BSC, and start-stop terminals do not have physical units and logical units and cannot use the SNA services available through VTAM.

## ***Distribution of Function***

VTAM uses the processing capabilities of the 3704 and 3705 Communications Controllers and the SNA terminals so that many functions formerly performed by the host CPU can be distributed to other network components. In general:

- VTAM allocates network resources.
- The communications controllers control data flow in the network.
- The programmed logic of certain SNA terminals formats data and processes local transactions.

By performing these functions outside the host:

- The host is relieved of minor requests.
- Processing and error recovery are performed closer to the terminal and user.
- Programmable SNA terminals can perform some remote processing when no connection to the host can be made.
- Daily processing can be done by remote programmable SNA terminals and then sent to the host to update a central data base.

## ***Sharing Resources***

Application programs that are executed in the central computer can share the following VTAM network resources:

- Communication controllers, control units, and lines
- Terminals

Communications controllers, control units, and lines may be used by more than one application program. An application program is unaware of these communications controllers, control units, and lines; it communicates only with terminals. VTAM controls the use of the paths to provide a logical connection between an application program and the terminals. In this way, several application programs may communicate with different terminals on a single line. Also, the terminals on the same line may communicate with any of the application programs using VTAM.

Terminals may be used by more than one application program. Any one terminal may communicate with any one of the application programs that is using VTAM. However, once a terminal begins to communicate with an application program, that terminal cannot communicate with another program until the first program breaks the logical connection and releases the terminal.

Figure 2-2 shows the sharing of resources in a VTAM network. When executed with VTAM, TCAM application programs may share resources in the same manner as VTAM application programs.

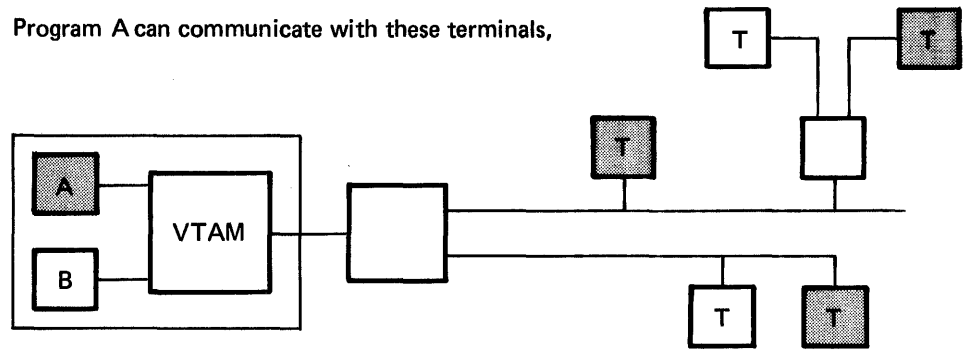
## **Application Programs**

A VTAM application program processes data received from a terminal in the network. The application program uses VTAM macro instructions to request connection to a terminal, and to transfer data between itself and the connected terminal.

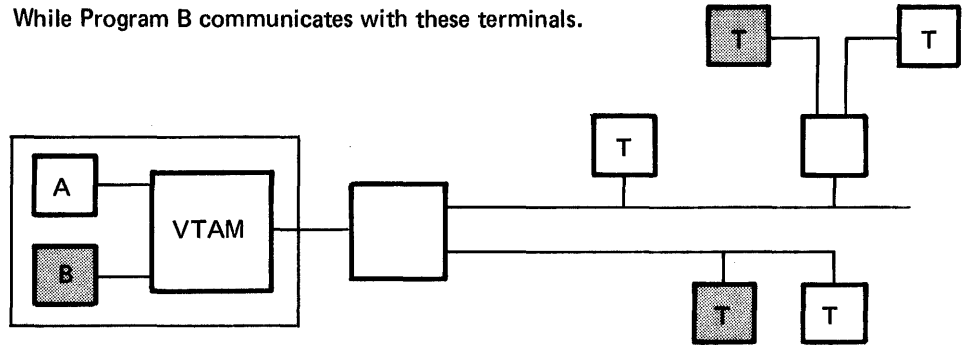
## ***Connection***

Connection is the process of making a network path available for communication between an application program and a terminal, and establishing the VTAM functions necessary to support that communication. Initially, all terminals in the network are available, through VTAM, for connection. Connection occurs when, in response to a connection request, VTAM makes a path available between an application program and a terminal. A connection request can be initiated by:

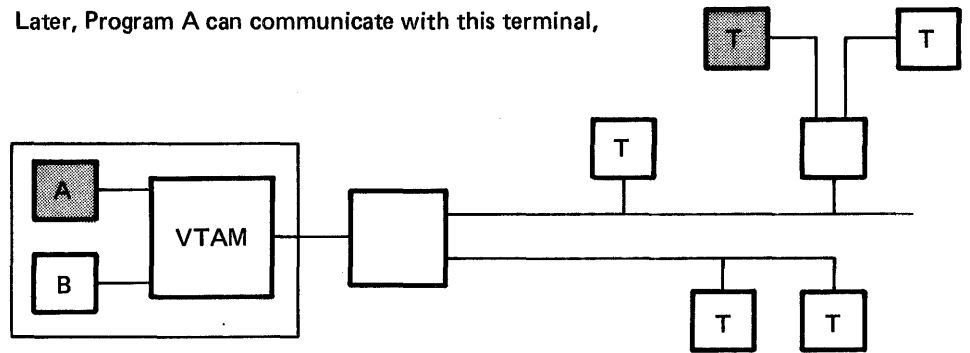
Program A can communicate with these terminals,



While Program B communicates with these terminals.



Later, Program A can communicate with this terminal,



While Program B communicates with these terminals.

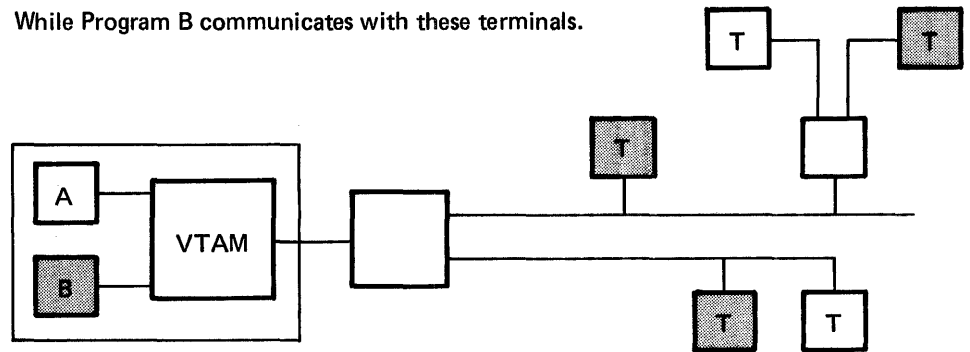


Figure 2-2. Sharing Resources

- A terminal. A terminal operator or the logic in an SNA terminal can send a logon request to an application program.
- VTAM (an automatic logon request). An installation can specify that a logon request is to be automatically generated on behalf of a terminal for a selected application program whenever that terminal is not connected to another program.
- The network operator. The network operator can enter a logon request on behalf of a terminal.
- A VTAM application program. An application program can request a terminal by simulating a logon request on behalf of the terminal or by requesting immediate connection to the terminal.

When VTAM receives a logon request from a terminal or on its behalf, the specified application program is notified of the request. The application program can then accept the terminal by requesting VTAM to make the connection or it can refuse the connection request.

As long as an application program and a terminal are connected, that terminal can communicate with only that application program. When the terminal is disconnected, it is available for connection to another program.

Connection requests originating from an SNA terminal can be sent to VTAM as a character-coded logon command or a field-formatted Initiate-Self command. A character-coded command is translated by VTAM and then processed as a field-formatted Initiate-Self command. A local 3270, BSC, or start-stop terminal requests connection by sending a character sequence which is interrupted by VTAM using an installation-defined interpret table.

To an application program, there are two ways of establishing connection: acceptance and acquisition. An application program accepts a terminal when VTAM connects the two in response to a request initiated by the terminal or on the terminal's behalf (for example, by the network operator). An application program acquires a terminal when VTAM connects the two in response to the program's request for immediate connection.

Although a terminal that is connected to one program cannot be used by another program, a second program can request connection to that terminal. The connected program is notified of the request, and can disconnect the terminal so that the requesting program can have it. The application program can, then, have terminals allocated to it, which it can release to other programs; and it can add more for its own use. All this is done while the program is being executed.

## *Transferring Data*

Once an application program has connected terminals, it can begin to communicate with those terminals by using one of the data-transfer methods available through VTAM. While the two data-transfer modes—record and basic—are used with specific terminal types, both modes may be used in the same application program. Refer to Appendix A for a list of the terminals supported by each mode of data transfer.

**Record Mode:** The functional difference between the basic and record modes of data transfer is that record mode is designed for use with intelligent network devices. Data is independent of the path or communication link control. The data stream can be any variable length and all combinations of 8 bits can be valid data. There is no required mapping of the data stream to accommodate path or link control. Using record mode, the application program can maintain simultaneous, independent input and output data flows with each terminal. To the application program, the terminal has a single address for both data flows. With record mode, the application program can respond independently to



input and output events without the need for complex polling or scanning techniques. All of these factors contribute to better utilization of the communication links.

**Basic Mode:** Basic mode is characterized as supporting conventional devices using start-stop or binary synchronous communication (BSC) line disciplines and local 3270 terminals. (Local and BSC 3270s are also supported in record mode. See “3270 Support” below.) The basic mode, which provides an effective means of managing a telecommunications network, supports only a *response mode* of operation, that is, a transmission/response sequence is implied for each transaction. Devices supported by basic mode must be specifically asked (solicited) to transmit data to the application program. The application program provides information to control the mechanical and formatting operations at the terminal, but it does not provide line control characters. VTAM, in conjunction with the communications controllers, provides the control characters needed to move the data through the telecommunication network.

**3270 Support:** VTAM supports local 3270 terminals in record or basic mode. Remote 3270s with a 3271 Model 1 or 2 Control Unit (or 3275 Model 1 or 2 Display Stations) are supported on BSC lines in record or basic mode. Remote 3270 with a 3271 Model 11 or 12 Control Unit (or 3275 Model 11 or 12 Display Stations) are supported on BSC lines in record or basic mode. Remote 3270 with a 3271 Model 11 or 12 Control Unit (or 3275 Model 11 or 12 Display Stations) are supported on SDLC lines in record mode.

### ***Exit Routines***

An application program can supply a comprehensive set of exit routines that VTAM invokes under the following conditions:

- A terminal has requested connection to the application program.
- A terminal has requested disconnection from the the application program.
- A transmission error has occurred.
- A terminal connected to the application program has been requested by another application program.
- VTAM has completed a requested task (for example, an input operation).
- Unrequested data has been sent from a terminal.
- The network operator has started VTAM shutdown procedures.

By using exit routines to handle certain events, an application program need not wait for completion of VTAM services or check periodically for special conditions.



## CHAPTER 3. CREATING A VTAM TELECOMMUNICATION SYSTEM

Three processes are involved in the creation of a VTAM telecommunication system:

- Defining VTAM, local terminals, and local 3704 and 3705 Communication Controllers to the operating system
- Defining the telecommunication network to VTAM
- Defining installation exit-routines and VTAM start options

### Defining VTAM, Local Terminals, and Local 3704 and 3705 Communication Controllers to the Operating System

During system generation, VTAM is specified as a parameter of the SUPVR macro instruction in DOS/VS or of the DATAMGT macro instruction in OS/VS. At that time, local terminals (3270 Information Display Systems and 3790 Communication Systems) and local 3704 and 3705 Communication Controllers are defined to the operating system. Note that since only local terminals and communication controllers are defined to the operating system, the configuration of the remote network can be changed without regenerating the system.

### Defining the Telecommunication Network to VTAM

Defining the telecommunication network to VTAM includes the following:

- Defining one or more network control programs (NCPs) for each 3704 or 3705 Communications Controller in the network
- Defining local 3270 Information Display Systems
- Defining VTAM application programs and groups of VTAM application programs
- Defining sets of terminals on switched lines
- Defining local 3790 Communication Systems
- Defining connection procedures

#### *Defining NCPs*

The 3704 and 3705 NCP-definition process specifies the numbers, types, and configurations of terminals to be attached to a 3704 or 3705 Communications Controller. The NCP has its own generation language, which consists of macro instructions that:

- Describe the 3704 or 3705 communications controller
- Specify NCP options
- Describe the interaction of the operating system with the NCP (such as buffers and block sizes)
- Describe lines and line groups
- Describe telecommunication terminal configurations, terminals, and terminal components

Some parameters in NCP-generation macro instructions provide information that is used by VTAM. The NCP macro instructions are assembled, verified, and used to generate the NCP. Later, VTAM dynamically interprets these NCP-generation statements and verifies the parameters it uses.

At least one NCP must be generated for each local or remote 3704 or 3705 Communication Controller. A communications controller may have more than one NCP generated for it; which NCP it will actually use will be determined later. Each NCP must have a

different symbolic name. Multiple NCPs for a communications controller are useful for installations that have varying telecommunication network requirements. Using different NCPs for different requirements allows the installation to alter terminal configurations as demands on application programs change and may make processing more efficient.

### ***Defining Local 3270 Terminals***

VTAM provides connection and data transfer services to the IBM 3270 Information Display System, which can be attached locally (through a channel) to the computer. When attached in this way, the display system is defined to VTAM with the LOCAL definition statement.

### ***Defining Application Programs***

An application program is defined using the APPL definition statement. Each application program is given a unique symbolic name, and may be defined by itself or as one of a group of application programs. For example, a university might set aside a portion of each day's computing time for student use and would want to have a group of student-oriented application programs in the system during that period. The operator could identify these application programs to the system in one step by defining them in one group.

### ***Defining Sets of Terminals on Switched Lines***

Each set of SNA terminals on switched (dial) lines is defined to VTAM using VBUILD, PU, LU, and PATH definition statements. These define the general characteristics of the terminals and their method of connection (manual dial-out, automatic dial-out, dial-in, and the telephone numbers to be used).

### ***Defining Local 3790 Communication Systems***

VTAM provides connection and data transfer services to IBM 3790 Communication Systems attached locally (through a channel) to the host processor. 3790s attached in this way are defined using VBUILD, PU, and LU definition statements.

### ***Defining Connection Procedures***

An SNA terminal can initiate connection and disconnection by sending a command to VTAM in one of two forms:

- A field-formatted command. This form of command is used by programmable SNA terminals. VTAM defines the format of the field-formatted commands; no installation action is needed to define these commands.
- A character-coded command. An installation using this form of command can use either the IBM-defined format of character-coded LOGON or LOGOFF commands, or, by building its own definition table, can define alternate forms of the commands. The character-coded command is converted to a field-formatted command by VTAM before processing.

Figure 3-1 illustrates the processing of connection and disconnection requests from SNA terminals.

Local 3270, BSC, and start-stop terminals initiate connection by sending a character sequence to VTAM. The character sequence is interpreted by VTAM using an installation-defined *interpret table* and then routed to the VTAM application program specified by the table. The interpret table is defined using the INTAB and LOGCHAR macro instructions.

During the connection process a VTAM application program and an SNA terminal establish a set of rules to be followed when communicating. These rules are called *session parameters*. Session parameters generally correspond to modes of application operation, such as batch or interactive operation. These session parameters can specify:

- Whether operation is half-duplex or full-duplex

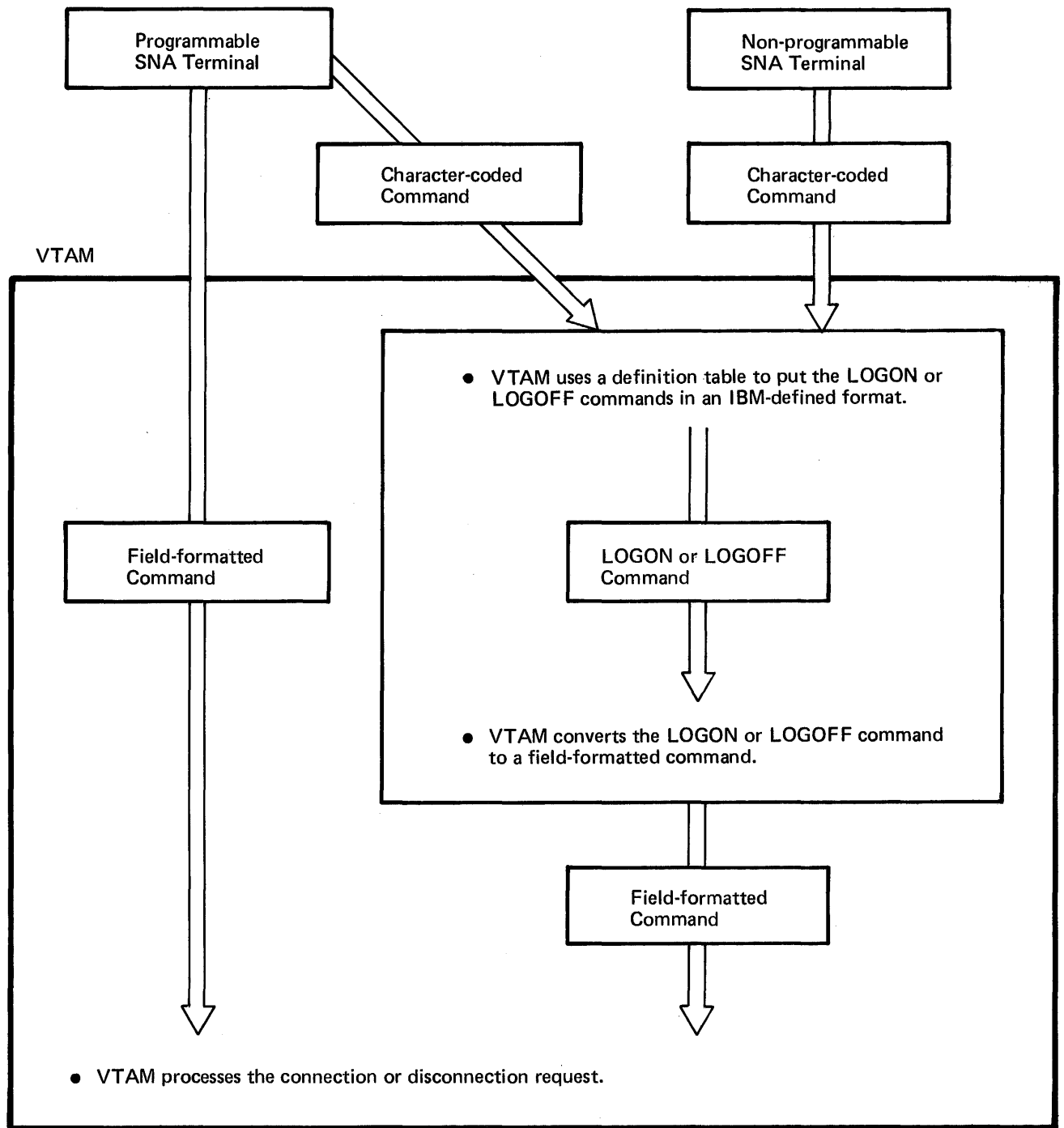


Figure 3-1. Processing Connection and Disconnection Requests from SNA Terminals

- Who has error-recovery responsibility
- Whether data can be chained
- Who can speak first

A set of session parameters can be associated with a symbolic name called a *logon mode name*. Each logon mode name is defined in a *logon mode table*. An installation can build a logon mode table to define its own set of logon mode names or can use the IBM-supplied logon mode table. Note that local 3270, BSC, and start-stop terminals do not use the variable session parameter facility; they use a fixed set of session parameters.

## Defining Installation Exit Routines and VTAM Start Options

In addition to defining the components of the VTAM network, an installation must define certain VTAM characteristics.

### *Defining Installation Exit Routines*

VTAM has application-program exit routines and installation exit routines. The application-program exit routines can be coded and identified in each application program that uses VTAM. These exit routines are executed as part of the application program. The installation exit routines for VTAM are coded and included as part of VTAM. These exit routines are automatically invoked by VTAM whenever an event occurs that is supervised by the routine. Installation exit routines are executed as part of VTAM and are not under the control of the application programs.

VTAM provides three types of installation exit routines:

- An authorization exit routine: Validates connection, disconnection, and logon requests.
- An accounting exit routine: Collects accounting information.
- A logon-interpret exit routine: Determines the appropriate application routine to receive a logon request. This facility is intended for use primarily with local 3270, BSC, and start-stop terminals using an interpret table. (Interpret tables are described in “Defining Connection Procedures,” above.)

### *Defining VTAM Start Options*

When the network operator starts VTAM, options can be specified to define VTAM facilities according to installation requirements. These options can be entered individually by the network operator or may be predefined in the VTAM definition library. The following start information can be specified:

- Which network components are to be traced by the VTAM trace facility
- Which network components are to be activated when VTAM is started
- The size of VTAM storage pools
- Whether certain network operator messages are to be suppressed
- The maximum number of network control programs (NCPs), sets of local 3270 terminals, sets of local 3790 terminals, and sets of application programs that will be active at any one time
- Whether the VTAM logon monitor facility for start-stop, BSC, and local 3270 terminals (called the *network solicitor*) is to be active initially

## CHAPTER 4. CONTROLLING THE VTAM NETWORK

Because a telecommunication network is a real-time environment, VTAM provides network operator commands for controlling the telecommunication devices and application programs in the network. Using these commands, a network operator can:

- Assist in increasing the efficiency of the telecommunication network
- Alter the network in response to fluctuating requirements of the installation
- Minimize the impact on the network if a part of the network fails

More specifically, the commands enable the operator to:

- Activate and deactivate terminals in the network
- Initiate requests for connection between terminals and application programs
- Dynamically redefine the network configuration
- Halt telecommunication activities in an orderly manner
- Monitor the telecommunication network
- Control some debugging programs
- Monitor application program status and each application program's use of network resources

The following commands are provided by VTAM:

**DISPLAY:** Displays the status of specific application programs, terminals, links, or 3704 or 3705 Communications Controllers, and displays path information about terminals on switched lines.

**MODIFY:** Enables the network operator to change the operating characteristics of VTAM and of the 3704 or 3705 communications controller. Specifically, **MODIFY** allows the operator to:

- Start or stop VTAM trace facilities
- Request a dump of the NCP
- Change the polling delay, the negative response to polling, the session limit, and the device transmission limit on a polled, nonswitched, start-stop or BSC line
- Print the trace file (DOS/VS only)
- Control the online testing programs

**VARY:** Enables the network operator to:

- Redefine the network (that is, to reconfigure the network by activating or deactivating terminals, lines, 3704 or 3705 Communications Controllers, or application programs)
- Switch lines, attached to a communications controller executing with PEP, between emulation mode and network control mode
- Load or deactivate NCPs
- Make a logon request to an application program on behalf of a terminal

**START:** Starts VTAM. The network operator can specify start options to define some VTAM facilities. See "Defining VTAM Start Options" in Chapter 3 for a description of VTAM start options.

**HALT:** Shuts down the telecommunication network and stops VTAM. When a **HALT** command is entered, VTAM prohibits any new logons and notifies application programs

of a pending shutdown. Application programs are allowed to continue I/O activity but should complete their activities quickly and in an orderly fashion. The network operator can also request a quick shutdown. In a quick shutdown, VTAM allows only read I/O operations for data already in VTAM buffers. If application programs do not promptly complete activities, the operator is informed of the continuing activity and may cancel the application program.



## CHAPTER 5. APPLICATION PROGRAM MACRO INSTRUCTIONS

VTAM provides macro instructions that enable an application program to establish and terminate a connection with a terminal and move data back and forth between itself and that terminal. The application program must set up control blocks that contain information used to direct these operations. The general sequence of macro instructions to establish connection and transfer data is described in this chapter. Figures 5-1 through 5-6 present a sample sequence of macro instructions that might be used to perform these functions.

### Identifying the Application Program to VTAM

An application program must begin execution by identifying itself to VTAM. It uses the ACB macro instruction to set up an access method control block (ACB), which indicates the name of the application program and may contain a password for authorization purposes. The application program's name is already contained in internal tables created during the network definition portion of system definition. The name will later be used to refer to terminals connected to this application program. An application program can use more than one ACB.

The EXLST macro instruction creates an exit list, which contains the addresses of exit routines that are to be given control under specified conditions. Some of these conditions are: receipt of logon requests from terminals, receipt of attention interruptions, and occurrence of unrecoverable I/O errors.

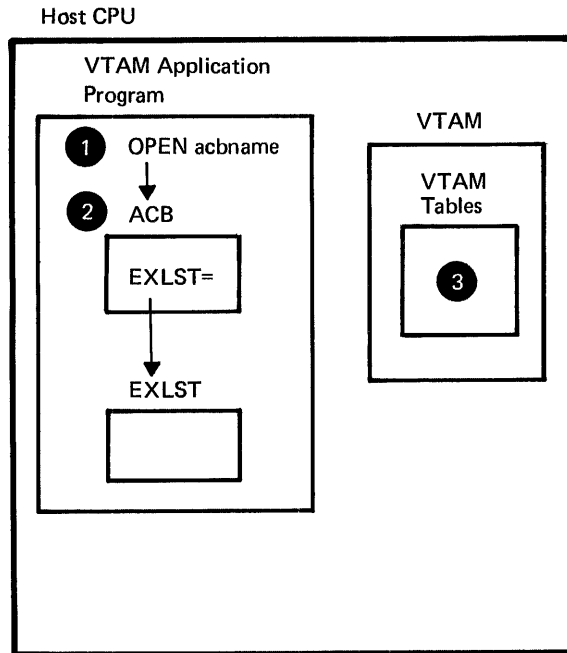
After the exit list has been established, the OPEN macro instruction (Figure 5-1) must be issued to indicate to VTAM that the ACB, and therefore the application program, is to be considered active.

### Establishing Connection

There are two methods of establishing connection. In the first, the application program accepts terminals for which logon requests have been entered. Either the application program accepting the logon requests, or some other application program, must have established procedures for accepting such requests. In the second method, the application program takes the active role, acquiring the terminals it needs.

Both methods of connection require a request parameter list (RPL) and a node initialization block (NIB), which are generated by RPL and NIB macro instructions or the GENCB macro instruction. In general, the RPL describes the service to be performed by VTAM (for example, establish connection). The RPL can contain the address of an exit routine to be invoked when VTAM completes the requested service. The RPL also includes the address of the NIB associated with the request and the address of the access method control block (ACB) associated with the application program. The NIB describes the terminal for which VTAM performs the service specified by the RPL.

An application program that is accepting logons from terminals may establish an exit routine for this purpose. When a logon request is entered by a terminal or for a terminal (by VTAM, the network operator, or an application program) this logon exit routine is called by VTAM to verify the logon request. When the logon exit routine issues an OPNDST macro instruction accepting the request (see Figure 5-2), the connection is complete.



- 1 The OPEN macro instruction specifies an access method control block (ACB).
- 2 The ACB contains information about the VTAM application program and can specify a set of user written exit routines to be invoked when specific events occur.
- 3 VTAM updates its internal tables to indicate that the VTAM application program is active and that the EXLST exit routines are eligible for scheduling.

Figure 5-1. The OPEN Macro Instruction

An application program acquires a terminal by issuing an OPNDST macro instruction with the ACQUIRE option. The OPNDST is completed when the terminal is connected to the application program.

If an application program that is receiving logon requests wishes to deny additional logon requests, either temporarily or in preparation for shutting down, the SETLOGON macro instruction is used.

## Supervising Connection

When there are several application programs in the VTAM teleprocessing system, the various terminals in the network may be connected to different programs at different times. Unless restricted by user-specified authorization, any available VTAM-controlled terminals can log on to any VTAM application program. When finished with one application program, the terminal can log on to another program.

VTAM coordinates and controls logon operations in the network and monitors the assignment of terminals for which control is desired. When a terminal asks to be logged on to an application program, VTAM informs the program of the request. Assignment of the terminal is transferred only when the application program accepts the request. If a program requests connection to a terminal, VTAM assigns the terminal to the application program. The terminal is returned to VTAM when the application program breaks the connection.

## Requesting Data Transfer

Using the record mode of data transfer, the application program first establishes a data flow environment before data transfer can begin. The data-flow environment is established either at the same time the connection is made (by issuing the OPNDST macro instruction), or at a subsequent time when the SESSIONC macro instruction is issued. After establishing the environment, data transfer can be initiated by either the application program, or the terminal in the network. Both input and output data flows may be maintained simultaneously with each connected terminal. Data received from the terminals is stored in VTAM buffers and is transferred to the application program when the RECEIVE macro instruction is issued. Data is transferred to the telecommunication terminal when the SEND macro instruction is issued. The general technique of data transfer is shown in Figures 5-3 and 5-4.

Using basic mode, data transfer operations can begin as soon as connection has been established. The data transfer process is initiated by soliciting data from the terminals connected to the application program. This function is performed by using the SOLICIT and READ macro instructions. If general network soliciting is used, that is, if all connected terminals are to be solicited, the SOLICIT macro instruction is issued to move data from any of the solicited terminals into VTAM buffers. The data from the first responding terminal is moved into the application program's input/output area when a subsequent READ macro instruction is issued. Meanwhile, VTAM will continue soliciting data from the other terminals. At the completion of the read operation, another SOLICIT macro instruction is issued for the terminal whose data was just read. General network soliciting allows VTAM to *read-ahead* of the user's immediate request for data to reduce delays in reading data. If the read-ahead function or general network polling is not desired, a READ macro instruction is used to perform both the solicit and the read operations. When writing to a terminal, the WRITE macro instruction transfers the data from the application program and then to the terminal. Incomplete data transfer requests may be canceled at any time by means of the RESET macro instruction.

## Disconnection

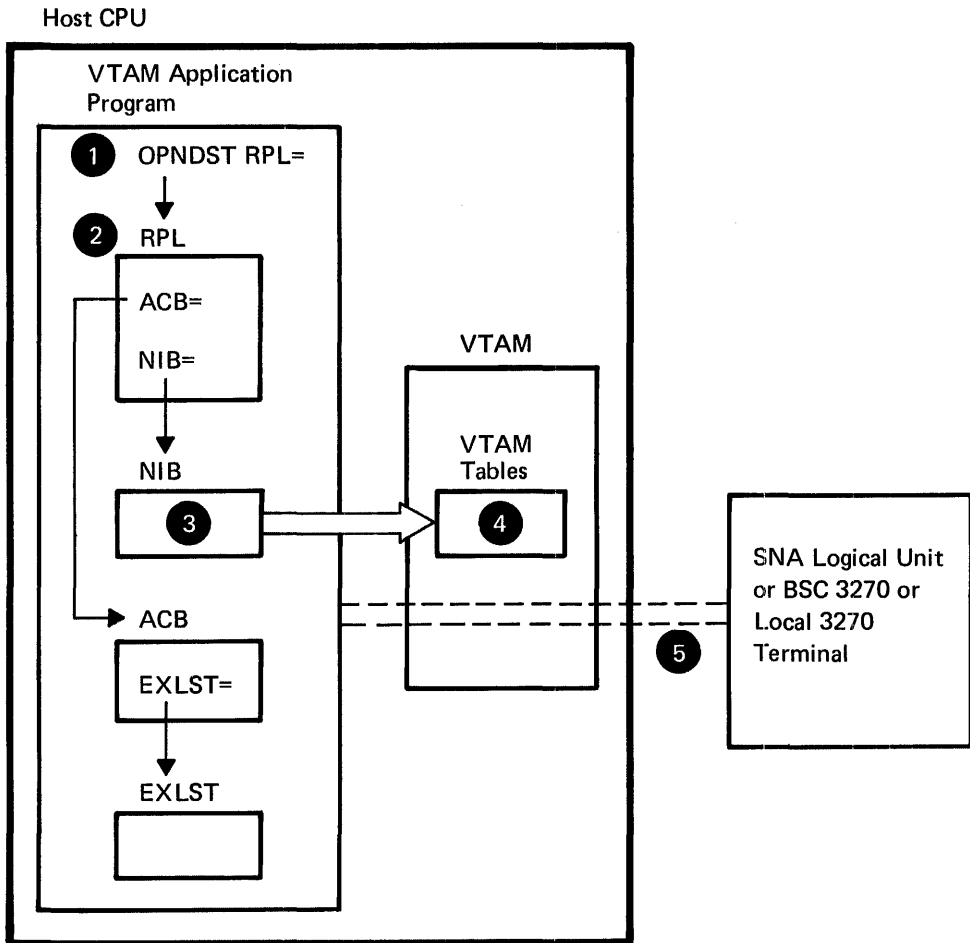
Disconnection can be initiated by:

- A terminal
- An application program
- The network operator

### ***Disconnection Initiated by a Terminal***

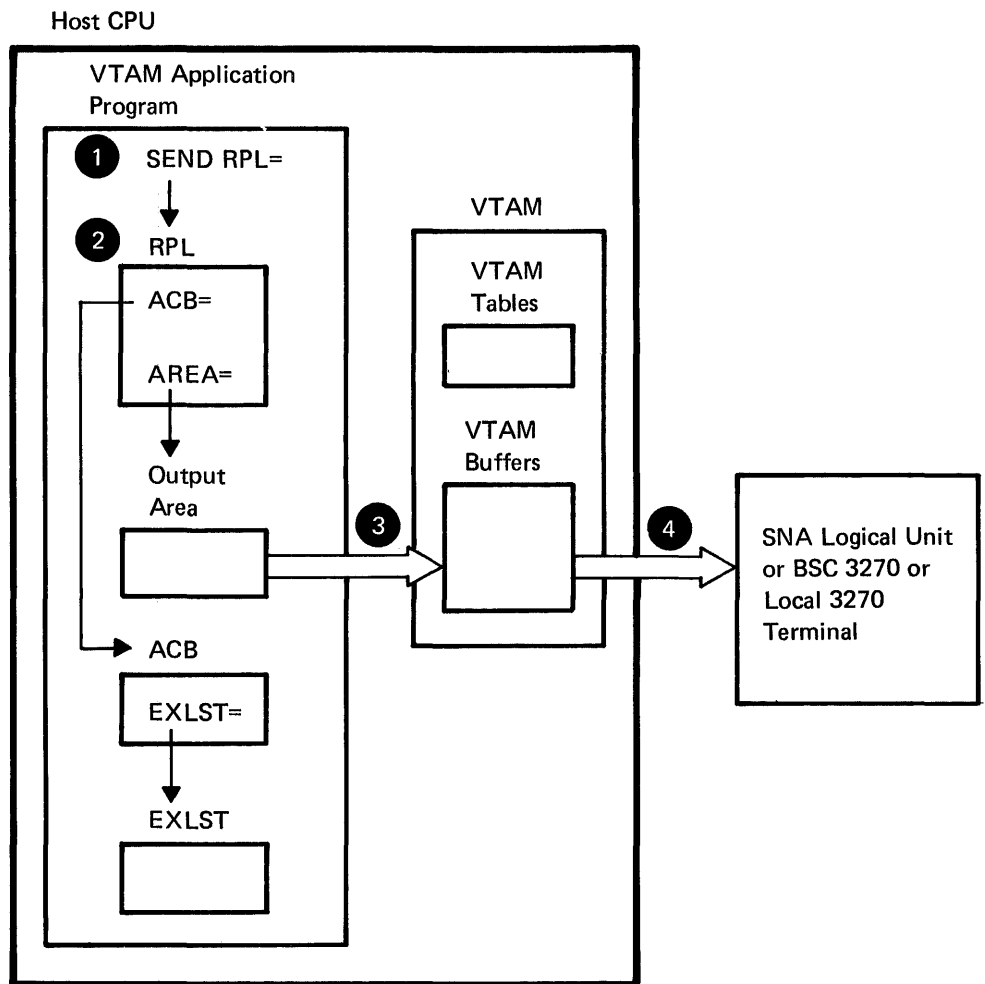
An SNA terminal can request conditional or unconditional disconnection from an application program. When conditional disconnection is requested, VTAM notifies the application program of the request by invoking its LOSTERM exit routine. The program then has the option of disconnecting the terminal or ignoring the request. When unconditional disconnection is requested, VTAM disconnects the terminal and then notifies the application program. Either type of disconnection request can be requested by sending a command to VTAM in one of the following forms:

- A character-coded LOGOFF command. VTAM converts the character-coded command into a field-formatted Terminate Self command.
- A field-formatted Terminate Self command. When a Terminate Self command is received (either directly or as the result of a VTAM conversion of a character-coded LOGON command), VTAM notifies the specified application program of the request. If conditional disconnection is requested, the program must issue a CLSDST macro instruction to disconnect the terminal, or ignore the request. If unconditional disconnection is requested, the application program should issue a CLSDST macro instruction to free the terminal even through it is disconnected.



- 1** The OPNDST macro instruction specifies a request parameter list (RPL).
- 2** The RPL describes the request for connection and specifies one or more node initialization blocks (NIBs).
- 3** Each NIB describes an SNA logical unit (LU) or BSC 3270 or local 3270 terminal to be connected. OPEN is also used to connect an application program with supported start-stop and BSC terminals.
- 4** When VTAM completes the connection request, the terminal information from the NIBs is moved into internal VTAM tables. VTAM notifies the application program by posting an ECB or scheduling an RPL exit routine.
- 5** The terminal or terminals are logically connected to the application program.

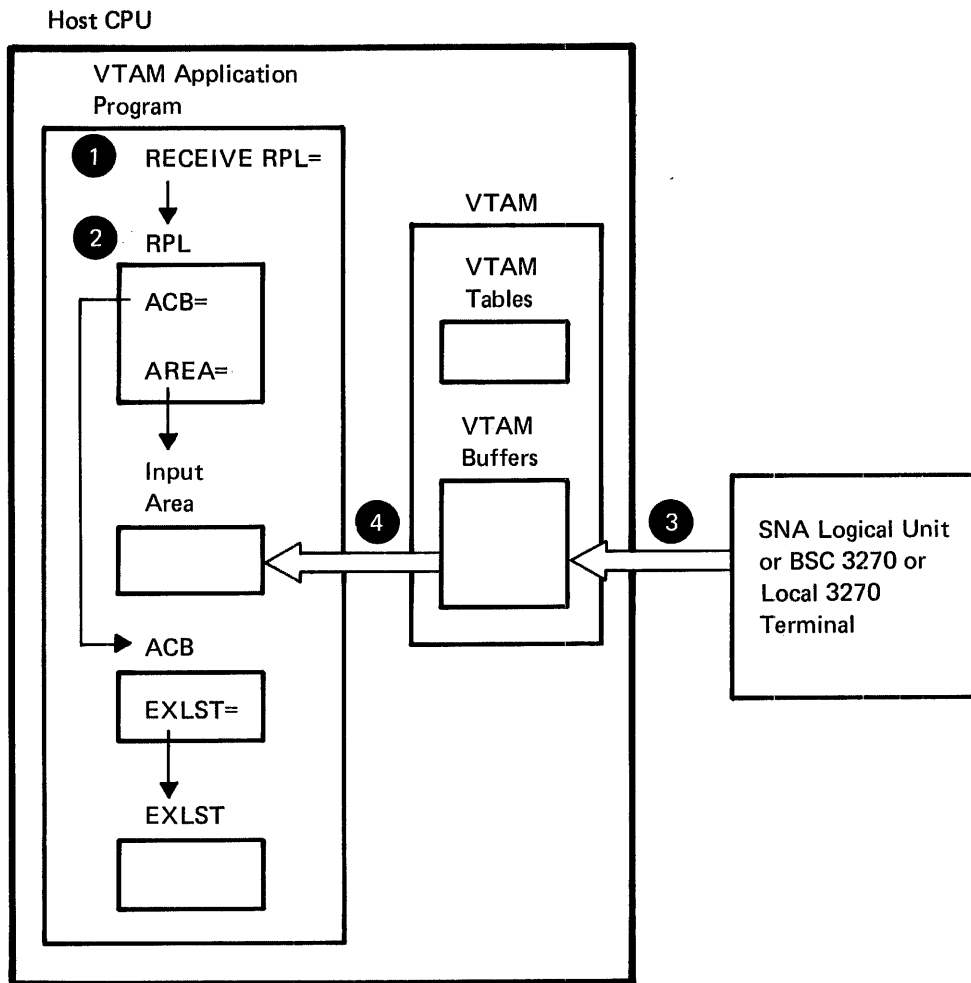
Figure 5-2. The OPNDST Macro Instruction



- 1 The SEND macro instruction specifies an RPL.
- 2 The RPL describes the data transfer request and specifies the output area to be used.
- 3 VTAM moves the data from the output area to VTAM's buffers.
- 4 VTAM moves the data from VTAM's buffers to the SNA logical unit or BSC 3270 or local 3270 terminal.

Note that an application program communicating with start-stop and BSC terminals (other than the BSC 3270) does not use the SEND macro instruction. Application programs use this instruction only in record mode.

Figure 5-3. The SEND Macro Instruction



- 1 The RECEIVE macro instruction specifies an RPL.
- 2 The RPL describes the data transfer request and specifies the input area to be used.
- 3 The SNA logical unit or local 3270 terminal sends data to VTAM's buffers. (This occurs independently of the RECEIVE.)
- 4 As a result of the RECEIVE, VTAM moves the data from VTAM's buffers to the specified VTAM application program input area.

Note that the RECEIVE macro instruction is used only in record mode.

Figure 5-4. The RECEIVE Macro Instruction

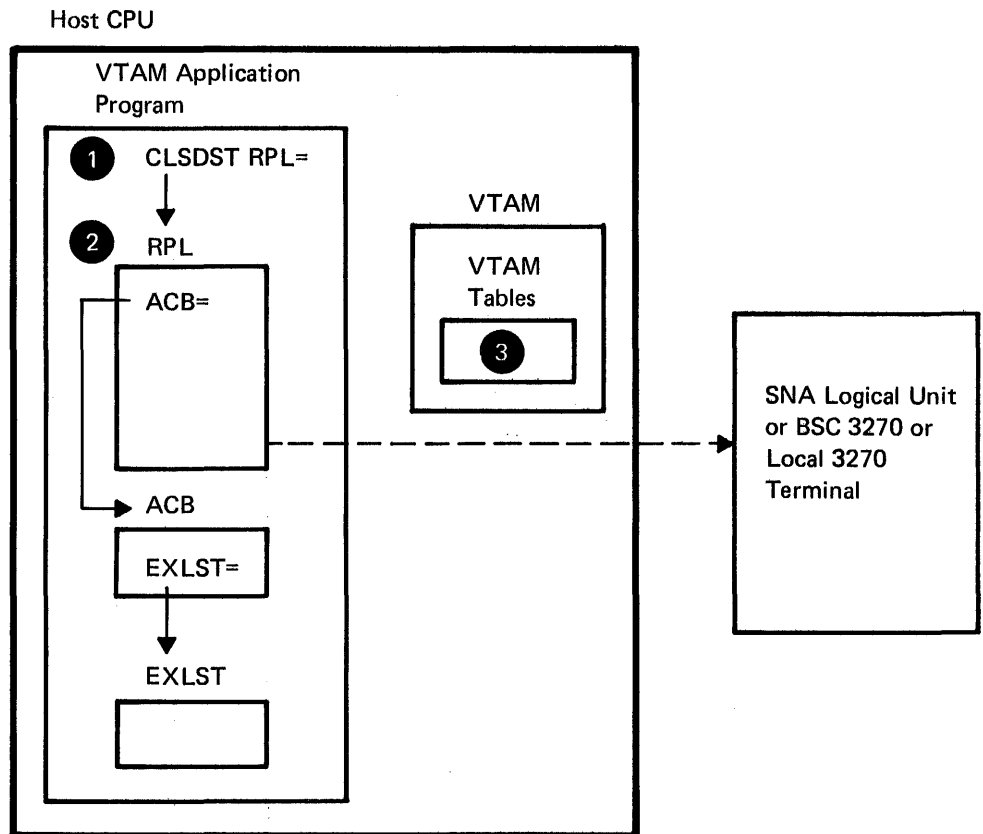
Local 3270, BSC, and start-stop terminals can request disconnection only by sending a message to the application program as part of the normal data flow. The application program must examine each message for such a request.

***Disconnection Initiated by an Application Program***

When an application program no longer needs a terminal, it can disconnect the terminal by issuing a CLSDST macro instruction. This type of disconnection might be the normal procedure for terminating a batch output type of operation. Figure 5-5 illustrates the CLSDST macro instruction.

***Disconnection Initiated by the Network Operator***

The network operator can cause a terminal to be disconnected from an application program. The operator issues the VARY command to deactivate the terminal and invoke the application program's LOSTERM exit routine. The application program should then issue a CLSDST macro instruction to disconnect the terminal.



- 1 The CLSDST macro instruction specifies an RPL.
- 2 The RPL describes the disconnection request to VTAM and identifies the terminal to be disconnected.
- 3 VTAM's internal tables are updated to indicate that the terminal is now available for connection to another application program.

CLSDST is also used to disconnect a program from supported start-stop or BSC terminals.

Figure 5-5. The CLSDST Macro Instruction

## Releasing and Passing a Terminal

When an application program issues a CLSDST macro instruction to complete the disconnection process, it specifies whether the terminal is to be released or passed. When a terminal is released, it is free to be connected to another application program. When a terminal is passed, a logon to a specified application program is generated. This type of CLSDST is useful when a sequence of application programs are to be used.

When an application program completes its processing, it issues a CLOSE macro instruction, which disconnects the application program from VTAM. (Figure 5-6).

## Building and Manipulating Control Blocks

An application program can build control blocks in two ways. During assembly of the program, ACB, EXLST, NIB, and RPL macro instructions generate their respective control blocks. An alternate method of creating these control blocks is to generate them during program execution using the GENCB macro instruction. The main advantage to this method of control block generation is that an application program need not be re-assembled if the format of a control block is changed. The ACB, EXLST, NIB, and RPL control blocks can later be inspected and modified using the MODCB, SHOWCB, and TESTCB macro instructions.

When the OPNDST macro instruction is issued, the contents of the NIB are placed in internal VTAM control blocks. Therefore, after a connection has taken place, the CHANGE macro instruction must be issued to place the contents of the modified NIB in the internal VTAM control blocks. The CHANGE macro instruction is valid only for devices that exclusively use the basic mode of data transfer.

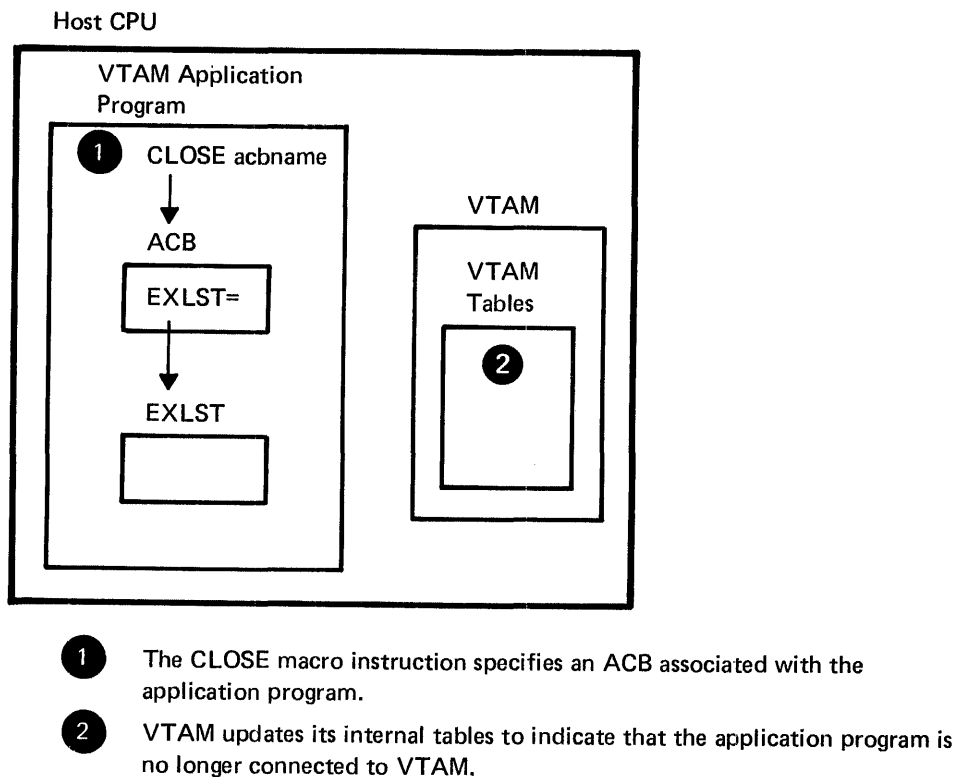


Figure 5-6. The CLOSE Macro Instruction



The INQUIRE macro instruction is used to obtain data from VTAM internal control blocks, whose contents are not determined by the application program. INQUIRE is primarily used to extract information about terminals issuing logon requests.

The INQUIRE macro instruction may be used to obtain:

- A logon message
- The characteristics of a terminal
- The number of active connections
- The number of logon requests waiting to be processed
- A NIB list
- The status of an application program
- The identification of a terminal or communications controller
- The name of the terminal at the head of the logon queue
- A set of session parameters

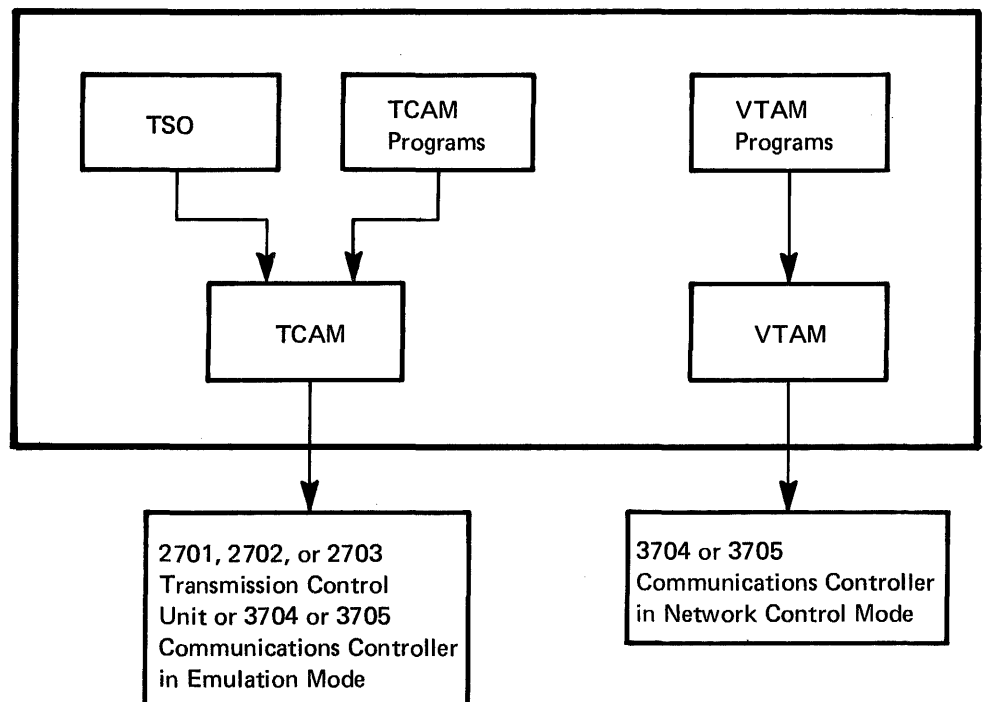


## CHAPTER 6. OTHER TELECOMMUNICATION ACCESS METHODS

VTAM is upward-compatible from DOS/VS to OS/VS1 and to OS/VS2 and can coexist with QTAM and BTAM under DOS/VS and with BTAM and TCAM under OS/VS. QTAM programs, BTAM programs, and TCAM programs that do not use 3704 or 3705 Communications Controllers in network control mode can be executed concurrently as long as they have separate telecommunication networks. Additionally, when VTAM and TCAM are both in the operating system, TCAM programs that use terminals attached to a 3704 or 3705 Communications Controller in network control mode are supported through VTAM. Figure 6-1 shows an OS/VS telecommunication system with TCAM and VTAM being executed concurrently.

### TCAM Programs under VTAM

TCAM application programs and the message control program (MCP) can share the resources of a VTAM telecommunication network with application programs written for VTAM. When sharing a network with TCAM, VTAM processes requests for all remote terminals attached to a 3704 or 3705 Communications Controller in network control mode and requests for all local 3790 Communication Systems. TCAM supports terminals attached to 2701, 2702, or 2703 transmission control units, terminals attached to a 3704



VTAM and TCAM programs use VTAM to communicate with terminals in the VTAM network attached by lines through a communications controller in network control mode. TCAM programs can also communicate with other remote terminals attached through 2701, 2702, or 2703 transmission control units, or through 3704 or 3705 Communication Controllers which are emulating these units.

Figure 6-1. Communications Controllers and Transmission Control Units in a Telecommunication Network

or 3705 Communications Controller in emulation mode, and all local terminals other than 3270s and 3790s. Local 3270 Information Display Systems can be supported by either VTAM or TCAM.

The principal advantages of this shared VTAM/TCAM capability are:

- The ability to share network resources between VTAM and TCAM programs
- The ability to allow terminals to log onto TCAM
- The availability of the direct-access device queuing capability of TCAM in a shared VTAM/TCAM network

Existing TCAM application programs that do not include TCAM operator commands should not require changes, recompilation, or reassembly; their interface with the TCAM MCP remains the same. However, the TCAM MCP will require reassembly to gain access to the NCP under VTAM control. TCAM applications that use TCAM operator control commands should be reevaluated to insure that they will operate as expected. When certain TCAM operator commands are issued from TCAM application programs or authorized terminals and directed to a terminal in the VTAM network (one attached to a 3704 or 3705, or a local 3270), the command will not be handled as in TCAM. Most commands that control the 3704 or 3705 and its network are to be directed to the VTAM operator control facility. The TCAM commands that previously provided these functions are either rejected (example, DUMP of the network control program) or provide a TCAM-only function without control of the physical network (example, SUSPXMITS stops TCAM transmissions to a terminal but allows other VTAM applications to send to it). As with the previous TCAM, the 2701-, 2702-, or 2703-related commands are rejected if directed to the VTAM NCP network.

The following TCAM macro instructions will be altered for VTAM operation; therefore, MCPs require reassembly:

```
CODE      INTRO      MSGFORM
MSGGEN    STARTMH    TERMINAL
```

Additional restrictions and considerations when using TCAM with VTAM are discussed in *VTAM Concepts and Planning*, GC27-6998.

## DOS/VS Coexistence

In a DOS/VS system, QTAM, BTAM, and VTAM can operate concurrently. QTAM and BTAM programs do not interact with VTAM. QTAM programs use QTAM, and BTAM programs use BTAM, to communicate with:

- Terminals attached to transmission control units
- Terminals attached to 3704 and 3705 Communications Controllers in emulation mode
- Local terminals (BTAM only)

VTAM application programs use VTAM to communicate with:

- Terminals attached to 3704 and 3705 Communications Controllers in network control mode
- Local 3270s
- Local 3790s

Lines attached to 3704 or 3705 Communications Controllers using the Partitioned Emulation Programming (PEP) extension may be used in either network control mode or emulation mode with an appropriate access method.

Figure 6-2 illustrates concurrent use of QTAM, BTAM, and VTAM in DOS/VS.

With concurrent execution of access methods, a single application program may use both BTAM and VTAM to communicate with separate networks, provided that all requirements of both access methods are met.

## OS/VS Coexistence

In an OS/VS system, BTAM, TCAM, and VTAM can operate concurrently.

BTAM application programs use BTAM, and TCAM application programs use TCAM, to communicate with:

- Terminals attached to transmission control units
- Terminals attached to 3704 and 3705 Communications Controllers in emulation mode
- Local terminals (except 3790s)

TCAM application programs use VTAM to communicate with:

- Terminals attached to 3704 and 3705 Communications Controllers in network control mode
- Local 3270s

VTAM application programs use VTAM to communicate with:

- Terminals attached to 3704 and 3705 Communications Controllers in network control mode

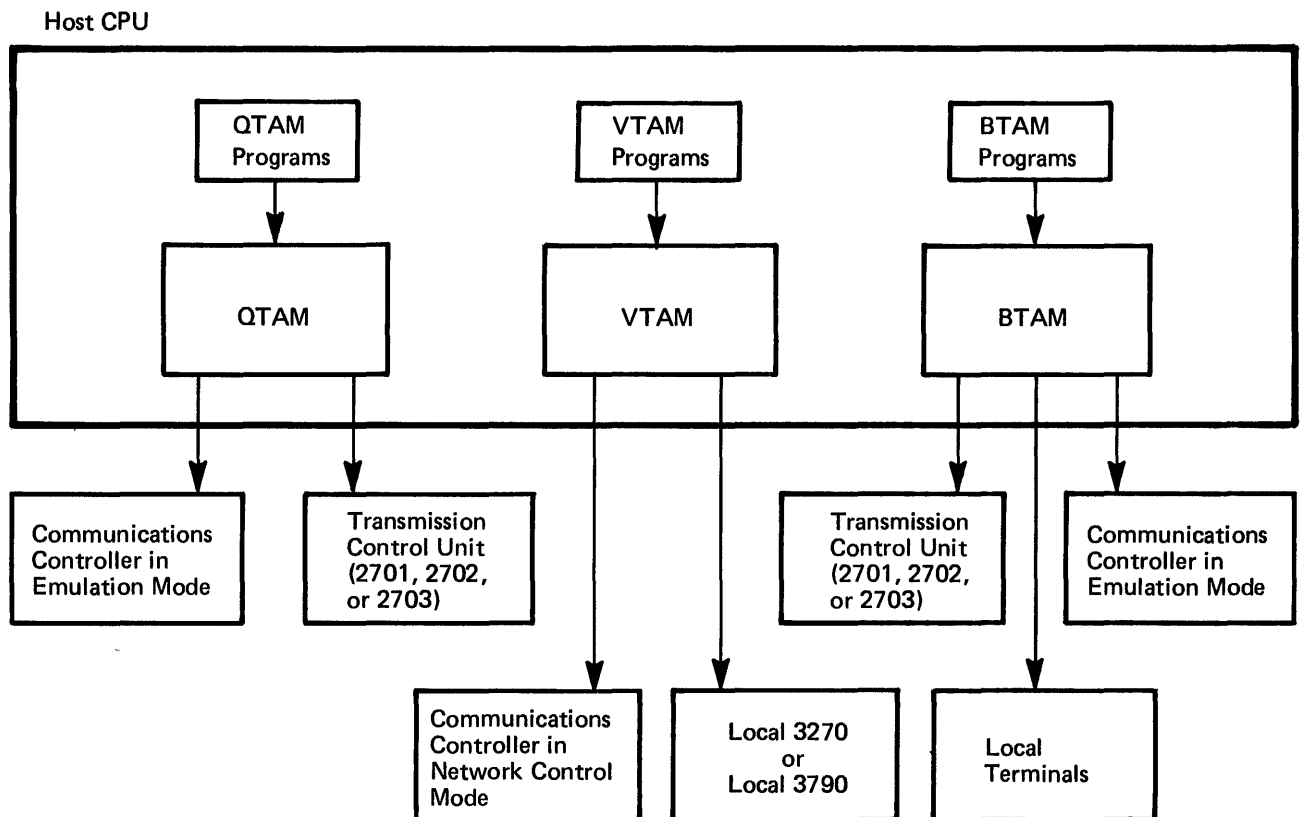


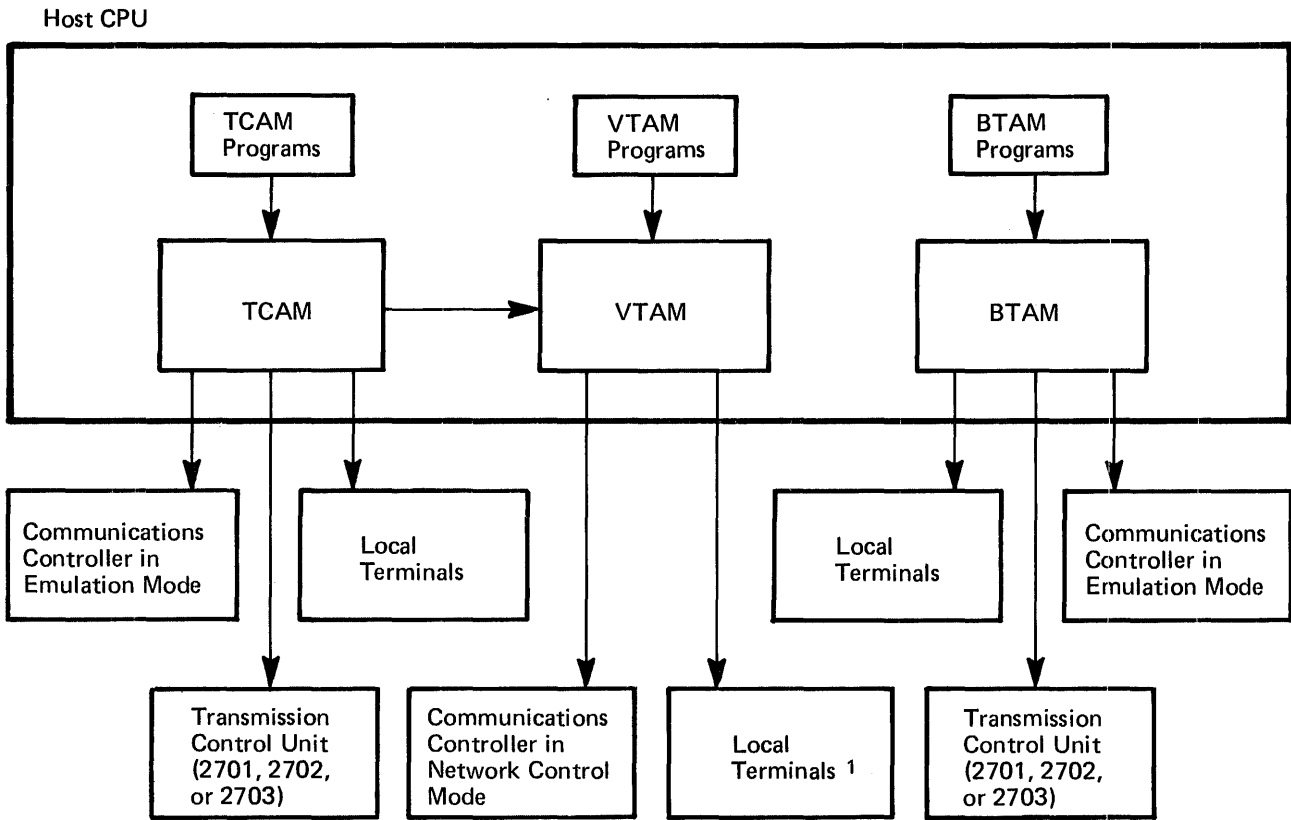
Figure 6-2. DOS/VS Coexistence

- Local 3270s
- Local 3790s

Lines attached to 3704 or 3705 Communications Controllers using the PEP extension may be used in either network control mode or emulation mode with an appropriate access method.

Figure 6-3 illustrates concurrent use of BTAM, TCAM, and VTAM in OS/VS.

With concurrent execution of access methods, a single application program may use both BTAM and VTAM to communicate with separate networks, provided that all requirements of both access methods are met. In addition, an application program can use both VTAM and TCAM; in this case, the networks can be separate or the same.



<sup>1</sup> VTAM programs can communicate locally with 3270 and 3790 terminal systems. TCAM programs using VTAM can communicate locally with 3270 terminal systems.

Figure 6-3. OS/VS Coexistence

## CHAPTER 7. RELIABILITY, AVAILABILITY, SERVICEABILITY

VTAM, in conjunction with DOS/VS, OS/VS1, and OS/VS2, provides a comprehensive set of reliability, availability, and serviceability (RAS) aids to maintain the performance of the telecommunication network. These aids are provided largely by the operating systems and are tailored to the needs of VTAM.

RAS aids may be divided into diagnostic aids and recovery aids. Diagnostic aids include operating-system traces and dumps, and the VTAM device diagnostic program TOLTEP (the teleprocessing online test executive program). VTAM processes the output from these facilities to make the results easier for VTAM users to interpret. Recovery procedures include operating-system hardware and software error-recovery programs, as well as 3704 and 3705 recovery aids.

### Diagnostic Aids

#### *Traces*

DOS/VS and OS/VS provide traces that help the user to determine whether a problem is the result of an error on his part or by the system and, in the latter case, which major system component caused the error.

**DOS/VS:** Trace facilities for DOS/VS are known as problem determination aids and serviceability aids (PDAIDs). They monitor fetch/load, I/O, SVCs, QTAM, and VTAM. Data collected by the PDAIDs provides a chronological record of certain VTAM activities and shows conditions that existed when an error occurred. The DOS/VS utility PDLIST can be used to print trace data.

**OS/VS:** The generalized trace facility (GTF) is the trace mechanism employed by OS/VS. This feature traces I/O, SVC, PCI, and external interruptions, and the dispatching of tasks in the operating system as well as in VTAM. In addition, GTF is used to record the VTAM trace data. The VTAM traces may be started or stopped at any time provided that GTF is active. The PRDMP utility is used to print GTF information. PRDMP can be used to print only VTAM information.

**VTAM:** In addition to the system traces, VTAM provides its own traces to record I/O activity, buffer information, and activity on lines attached to the NCPs. These traces may be started or stopped at any time using parameters in the START or MODIFY commands, and they may be executed concurrently. In DOS/VS the trace data is stored in a VTAM trace file and printed using a VTAM trace print utility. In OS/VS the trace data is collected by the generalized trace facility and printed using the PRDMP utility.

#### *Formatted Dumps*

Two formatted dump programs are available to VTAM users through OS/VS. They are ABDUMP and a service-aids dump.

**ABDUMP:** ABDUMP is called with the operating system's ABEND or SNAP macro instruction. The dump consists of the major control blocks of the terminated task, its subtasks, and its direct callers, as well as any pages within the failing partition or region that were referred to during execution and are still allocated. Dumps of programs using VTAM or TCAM operating with VTAM are formatted by the VTAM or TCAM formatted-dump programs. The VTAM formatted-dump program examines VTAM control blocks and prints diagnostics if control block chains are broken or invalid addresses are present.

**Service-Aids Dump:** Stand-alone service aids in OS/VS are provided to dump the contents of main storage to printer or tape. The utilities are HMDSADMP in OS/VS1 and AMDSADMP in OS/VS2. These utilities do not produce formatted control blocks. For dumps that are printed by PRDUMP, however, the VTAM formatted-dump program may be invoked to format control blocks associated with VTAM applications from the original dump.

### ***TOLTEP***

The Teleprocessing Online Test Executive Program (TOLTEP) is a test program that oversees the execution of online testing of telecommunication devices. It operates with DOS/VS, OS/VS1, and OS/VS2 in much the same fashion as OLTEP.

TOLTEP allows online tests to run while the telecommunication network continues normal operations. The online tests perform diagnostic procedures on and verify the operation of devices. More than one online test may be run at a time. TOLTEP is included in the system when VTAM is generated and is started and stopped with VTAM. For more information on TOLTEP, see *DOS/VS and OS/VS TOLTEP for VTAM*, GC28-0663.

### ***Error Recording***

**Hardware Errors:** VTAM uses its own error-recovery procedures to compile statistical information on I/O errors. These procedures interface with the operating-system recording facilities to format and write the error records to a direct-access device. In DOS/VS the recovery management support recorder is used to record errors on both locally and remotely attached terminals. In OS/VS the outboard recorder is used to record errors on locally attached terminals, while the miscellaneous data recorder is used to record errors on remotely attached terminals.

For locally attached terminals, two types of error records are written: permanent-error records and counter-overflow/end-of-day error records. A permanent-error record is written when the VTAM error-recovery procedures either encounter an undefined or unanticipated error, or have been unsuccessful in retrying the I/O operation. A counter-overflow/end-of-day error record is written when one of the counters updated by VTAM is ready to overflow, or when an end-of-day situation occurs. Two counters are maintained in VTAM; one counter saves the count of temporary errors (errors corrected by the error-recovery procedures), and the other saves the count of Start I/O commands issued. Other counters are maintained in the operating-system device statistics table of unit check errors by error type for each locally attached terminal. All of the counters appear in each record, and after the record is written, the counters are reset to 0.

I/O errors on remote terminals attached to a local communications controller are processed by routines in the network control program in the communications controllers. However, error information on the cause of the error is passed to VTAM for forwarding to the operating-system recording facilities.

**Software Errors (OS/VS only):** The Software Error Recording Facility (SRF) is used by VTAM. Special VTAM routines receive control on ABEND conditions, machine checks, or unanticipated program checks. Control is then passed to SRF routines for error recording and then to retry routines.

### ***Printing Error Records***

The operating system's error recording edit and print program (EREP) can be used to select, format, and print the error records.

### ***Audit/Reconstruct***

Audit/reconstruct is designed to analyze the following situations:



**Invalid Parameters:** A routine that can determine that its processing is hindered by an invalid parameter returns any system resources it has acquired and sends a return code indicating this error to its caller.

**Environmental Errors:** These are temporary setbacks such as “device not available.” These errors are also communicated to the calling routine by means of a return code.

## Recovery Aids

### **Error-Recovery Procedures**

**Hardware Errors:** When an I/O error interruption occurs for a locally attached terminal, VTAM error-recovery procedures determine the type of error from the CSW and sense information and attempt recovery. The method used to attempt recovery is device dependent and is described in the functional characteristics manual for each terminal.

Error-recovery procedures for terminals, control units, and lines attached to the 3704 or 3705 in network control mode are provided by the NCP.

**Software Errors (OS/VS only):** Software error-recovery procedures are closely connected with the error exit routines established by the STAE or ESTAE macro instruction. These routines are system dependent, providing more function in OS/VS2.

The general approach to software error recovery is an attempt to isolate the error and to limit its effect on other parts of the system. In certain instances, VTAM attempts to reinitialize a failing module in order to maintain the function. In other instances, VTAM terminates a failing application program, or deactivates a failing portion of the network to allow the remaining operations to continue. Where possible, VTAM will reallocate resources no longer in use.

### **Restart/Recovery**

The restart and recovery facilities safeguard the operating system and 3704 or 3705 Communications Controller environments. The facilities allow a 3704 or 3705 Communications Controller to be restarted and allow reestablishment of the network configuration.

**Configuration Restart:** VTAM maintains in virtual storage a table of status information on the network configuration supported by all active NCPs. If an NCP fails, the NCP is first reloaded; then VTAM returns the network to the configuration that existed when VTAM was started.

**Integrity of Application Program Data:** The VTAM posting facilities, which use the CHECK macro instruction, help provide data integrity in case VTAM or an NCP fails. An application program requests notification when its message has been completely transmitted. If the transmission is not successful, the application program is informed. The application program is assumed to be holding the message buffer until notified of a complete transmission. If VTAM fails, application programs can disconnect from VTAM terminals and continue with other processing until VTAM is restarted. If the 3704 or 3705 has encountered a temporary error, the application reissues its request. On a 3704 or 3705 permanent error, the application should disconnect terminals attached to that 3704 or 3705, but may continue execution, using other terminals.



## APPENDIX A. SUPPORTED TERMINAL PRODUCTS

This appendix lists the terminal products supported by VTAM. Supported terminals are grouped as:

- SNA terminal products, in turn grouped as:
  - Local SNA terminal products
  - Remote SNA terminal products
- Local 3270, BSC, and start-stop terminals, in turn grouped as:
  - Start-stop terminals
  - BSC terminals
  - Local 3270 terminals

### *Communications Controllers*

VTAM supports the IBM 3704 and 3705 Communications Controllers with a network control program (NCP) in network control mode either alone or as part of the Partitioned Emulation Programming (PEP) extension. The communications controllers can be attached locally (by channels) or remotely (through a local 3704 or 3705 Communications Controller).

VTAM does not support either the 2701, 2702, or 2703, or the emulation mode functions of the NCP, alone or as part of PEP.

### *Equivalent Terminals*

Terminals that are functionally equivalent to those specifically supported by VTAM may also function satisfactorily with VTAM; the customer is responsible for establishing equivalency.

## SNA Terminal Products

SNA terminals consist of local and remote terminal products. Local terminal products are attached directly to the CPU on a channel. Remote terminal products are attached on SDLC lines to either a local or a remote communications controller. The communications controller must contain a network control program.

### *Local SNA Terminal Products*

VTAM supports the IBM 3790 Communication System attached by channels to the CPU. 3790 Communication Systems use the record mode of data transfer.

### *Remote SNA Terminal Products*

The following SNA terminal products are supported by VTAM attached on an SDLC line to a local or remote communications controller (3704 or 3705). Remote SNA terminals use the record mode of data transfer.

- 3270 Information Display System on nonswitched lines
- 3600 Finance Communication System on nonswitched lines
- 3650 Retail Store System (U.S. and Canada only) on switched or nonswitched lines
- 3660 Supermarket System on switched lines
- 3767 Communication Terminal (Models 1 and 2) on switched or nonswitched lines
- 3770 Data Communication System on switched or nonswitched lines
- 3790 Communication System on switched or nonswitched lines
- System/32 Batch Work Station on switched or nonswitched lines

## Local 3270, BSC, and Start-Stop Terminals

Start-stop and BSC terminals can be attached to either a local or remote communications controller in network control mode. Local 3270 terminals are attached by a channel to the CPU. VTAM supports start-stop and BSC terminals using the basic mode macro instructions. The BSC 3270 and local 3270 terminals are supported using either the basic mode or record-mode macro instructions.

### *Start-Stop Terminals*

The following start-stop terminals can be attached to either a local or a remote communications controller in network control mode:

- 1050 Data Communication System on switched or nonswitched lines
- 2740 Communication Terminal (Model 1) on switched or nonswitched lines, with or without checking, and with or without station control or transmit control
- 2740 Communication Terminal (Model 2) on nonswitched lines, with or without checking, and with or without the Buffer Receive feature
- 2741 Communication Terminal (Model 1) on switched or nonswitched lines
- 3767 Communication Terminal (Models 1 and 2) supported as a 2740 Model 1, 2740 Model 2, or 2741 on switched or nonswitched lines
- Communicating Magnetic Card SELECTRIC® Typewriter on switched lines (supported as a 2741 terminal)
- AT&T 83B3 Selective Calling Stations on nonswitched lines
- Western Union Plan 115A Outstations on nonswitched lines
- CPT-TWX Terminal (Models 33 and 35) on switched lines
- World Trade Telegraph Terminals on nonswitched lines
- System/7 Processor Station on switched or nonswitched lines (supported as a 2740 Model 1 with checking)

### *Binary Synchronous Communications (BSC) Terminals*

BSC terminals can be attached to either a local or remote communications controller in network control mode. The devices listed below are supported.

- 2770 Data Communication System on switched or nonswitched lines
- 2780 Data Transmission Terminal on switched or nonswitched lines
- 2980 General Banking Terminal System (United States only) (Batched message mode not supported)
- 3270 Information Display System on nonswitched lines
- 3735 Programmable Buffered Terminal (Model 1) on switched or nonswitched lines
- 3740 Data Entry System on either switched or nonswitched lines (supported as a System/3)
- 3750 Switching System on nonswitched lines (World Trade only)
- 3770 Data Communication System (when available) on switched or nonswitched lines (supported as a 2770)
- 3780 Data Communications Terminal on switched or nonswitched lines. (If the 3780 does not include the card-punch component, the 3780 is supported as a 2770 without component select. If the 3780 does include the card-punch component, the 3780 is supported as a 2770 with component select.)
- 5275 Direct Numerical Control Station (Model 1) supported as a 3275 Model 2 on switched or nonswitched lines (United States only)
- System/3 Processor Station on switched or nonswitched lines

- System/7 Processor Station on switched or nonswitched lines (supported as a System/3 with Binary Synchronous Communications Adapter (2074))
- System/370 (Models 115-168 MP) on switched or nonswitched lines (as a remote station)

***Local 3270 Terminals***

VTAM supports the 3270 Information Display System attached locally (by channels) to the CPU.



## APPENDIX B. VTAM MACRO INSTRUCTIONS

<b>Instruction</b>	<b>Function</b>
ACB	Creates (during assembly) a control block to contain information about an application program.
CHANGE	Places changes to a NIB in internal VTAM tables. (Used only with devices that exclusively use basic mode.)
CHECK	Determines whether an RPL-based operation is complete and whether there are error conditions.
CLOSE	Disconnects an application program from VTAM.
CLSDST	Breaks a connection between an application program and a terminal.
EXLST	Creates (during assembly) a list of addresses of exit routines.
GENCB	Creates (during execution) one or more ACB, EXLST, NIB, or RPL control blocks.
INQUIRE	Provides information from fields of VTAM's internal control blocks.
MODCB	Changes (during execution) fields of an ACB, EXLST, NIB, or RPL control block.
NIB	Creates (during assembly) a control block that identifies a terminal.
OPEN	Connects an application program to VTAM.
OPNDST	Connects a terminal to an application program.
READ	Transfers data from VTAM buffers to an application program (basic mode only).
RECEIVE	Transfers data from VTAM buffers to an application program (record mode only).
RESET	Cancels data-transfer requests (basic mode only).
RESETSR	Cancels data-transfer requests (record mode only).
RPL	Creates (during assembly) a control block containing connection and processing information.
SEND	Moves data from an application program to an SNA logical unit (record mode only).
SESSIONC	Used to change the data-flow environment (record mode only).
SETLOGON	Starts and stops the acceptance of logon requests for an application program.
SHOWCB	Moves the contents of an ACB, EXLST, NIB, or RPL control block field to a designated area.
SIMLOGON	Requests VTAM to create and queue a logon request on behalf of specified terminals.
SOLICIT	Moves data from a terminal into VTAM buffers (basic mode only).
TESTCB	Tests the contents of an ACB, EXLST, NIB, or RPL control block field and sets the program status word (PSW) condition code accordingly.
WRITE	Moves data from an application program to a terminal (basic mode only).





# GLOSSARY

*Note: Terms marked (SNA)—for example, field formatted. (SNA)—are defined in the Systems Network Architecture (SNA) publications. The definitions in this glossary explain what the terms mean in a VTAM context.*

**ACB.** Access method control block.

**accept.** To connect a terminal to an application program in response to a logon request from that terminal.

**access method control block (ACB).** In VTAM, a control block that links an application program to VTAM.

**accounting exit routine.** An installation-coded routine invoked by VTAM to collect statistics for each connection and disconnection request.

**acquire.** To connect a terminal to a VTAM application program in the absence of a logon request from the terminal.

**active.** Pertaining to a major node that is known to VTAM and is available for use in the network or pertaining to a minor node that is connected to, or is available for connection to, a VTAM application program. Contrast with *inactive*.

**application program.** See *VTAM application program*.

**APPLID routine.** An installation-coded exit routine that assists in the translation of an argument for an interpret table. The routine may provide another level of authorization that has to be passed by a logon request.

**authorization exit routine.** An installation-coded routine that is invoked by VTAM for each connection and disconnection request to determine whether the request should be processed.

**basic mode.** The facilities (including the macro instructions needed to use them) that enable a VTAM application program to communicate with local 3270, BSC, and start-stop terminals.

**binary synchronous communication (BSC).** Communication using binary synchronous transmission.

**binary synchronous transmission.** Data transmission in which synchronization of characters is controlled by timing signals generated at the sending and receiving stations. Contrast with *stop-start transmission*.

**block.** In the basic mode of VTAM, the smallest unit of data that may be transmitted between a VTAM application program and a terminal. The maximum size of a block is determined by the characteristics of the device that is sending or receiving the data.

**BSC.** Binary synchronous communication.

**character-coded. (SNA)** Pertaining to a logon or logoff command, usually entered by a terminal operator from a keyboard and sent by a logical unit in character form. The character-coded command must be in the syntax defined by the installation. Contrast with *field-formatted*.

**communication control unit.** A communication device that controls the transmission of data over lines in a telecommunication network. Communication control units include transmission control units and communications controllers.

**communication line.** Any physical link, such as a wire or a telephone circuit, that connects one or more remote terminals (or a remote computer) to a communication controller, or connects one communication controller to another.

**communication link.** The physical means of connecting one location to another for the purpose of transmitting and receiving data.

**communication terminal.** A mechanical, electrical, or electronic contrivance capable of transmitting information between points of origin and reception.

**communications controller.** A type of communication control unit whose operations are controlled by a program stored and executed in the unit. Examples are the IBM 3704 and 3705 Communications Controllers. Contrast with *transmission control unit*.

**configuration.** The group of machines, devices, and programs that make up a data processing system.

**configuration restart.** In VTAM, the facility for reloading an NCP automatically following a failure in an NCP or in the communications controller containing that NCP and the facility for reestablishing contact with a physical unit after contact has been lost. Configuration restart includes the ability to restore the network to its status just prior to the failure.

**connection.** In VTAM, in response to a request (OPNDST) from a VTAM application program, the linking of VTAM control blocks in such a way that the program can communicate with a particular terminal. The connection process includes establishing and preparing the network path between the program and the terminal.

**control unit.** A device that controls input/output operations at one or more devices.

**converted command.** An intermediate form of a character-coded logon or logoff command produced by VTAM through use of a definition table. The format of a converted logon or logoff command is fixed; the definition table must be constructed in such a manner that the character-coded command (as entered by a logical unit) is converted into the predefined converted command format. If an unmodified IBM-supplied definition table is used, the character-coded command must be entered in the converted command form. By modifying the definition table, the installation permits variations in the character-coded command formats. VTAM changes the converted command into an Initiate Self or Terminate Self command.

**data transfer.** In telecommunications, the sending of data from one point in the network to another.

**device-control character.** A control character that is embedded in a data stream to control mechanical and format operations at a terminal (for example, a line-feed character or carriage-return character). See also *line-control character*.

**disconnection.** In VTAM, the disassociation of VTAM control blocks in such a way as to end the session between a VTAM application program and a connected terminal. The disconnection process includes suspending the use of the network path between the program and the terminal.

**exit list (EXLST).** In VTAM, a control block that contains the addresses of routines that will receive control when specified events occur during VTAM execution. Exit routines handle events such as logon processing and I/O errors.

**exit list routine.** See *EXLST exit routine*.

**EXLST.** *Exit list*.

**EXLST exit routine.** A routine whose address has been placed in an exit list (EXLST) control block. The addresses are placed

there with the EXLST macro instruction, and the routines are named according to their corresponding operand; hence DFASY exit routine, TPEND exit routine, RELREQ exit routine, and so forth. All exit routines are coded by the VTAM application programmer.

**field-formatted.** (SNA) Pertaining to a logon or logoff command from an SNA terminal in the SNA-defined format of an Initiate Self or Terminate Self command. This format allows the logon or logoff request information to be in a specified format, such as binary codes, bit significant flags, or symbolic names in defined fields. Contrast with *character-coded*.

**host CPU.** The central processor for a VTAM telecommunication system. VTAM resides in the host CPU.

**inactive.** Pertaining to a major node that is unknown to VTAM and is unavailable for use in the network or pertaining to a minor node that is not connected to, nor is available for connection to, a VTAM application program. Contrast with *active*.

**Initiate Self command.** (SNA) A command that is sent by a logical unit to VTAM requesting a session between the logical unit and a VTAM application program.

**installation exit routine.** Any of several types of special-purpose exit routines that an installation uses in common for all active VTAM application programs. The installation can code and specify an accounting exit routine, an authorization exit routine, and a logon-interpret exit routine.

**interpret table.** In VTAM, an installation-defined correlation list that translates an argument into a string of 8 characters. Interpret tables can be used to translate a logon message into the name of a VTAM application program for which the logon request is intended.

**line.** See *communication line*.

**line-control character.** For start-stop or BSC terminals, character in a data stream that controls the transmission of data over a network path. For example, line-control characters delimit messages and indicate whether a terminal has data to send or is ready to receive data. See also *device-control character*.

**line group.** One or more lines of the same type that can be activated or deactivated as an entity.

**link.** See *communication link*.

**local.** Pertaining to the attachment of devices directly by channels to a host CPU. Contrast with *remote*.

**log on.** To request that a terminal be connected to a VTAM application program. See also *logon request*.

**log off.** To request that a terminal be disconnected from a VTAM application program. See also *logoff request*.

**logical unit.** (SNA) The end point of an SNA terminal product with which a VTAM application program communicates.

**logoff command.** A request by a logical unit to be disconnected from the VTAM application program to which it is connected. Logoff commands occur either as *field-formatted Terminate Self* commands or as *character-coded logoff* commands.

**logon command.** A request by a logical unit to be connected to an application program. Logon commands occur either as *field-formatted Initiate Self* commands or as *character-coded logon* commands.

**logon message.** In VTAM, the data that can accompany a logon request received by the VTAM application program to which the request is directed. A VTAM application program, before connecting to the terminal with the OPNDST macro instruction can use the INQUIRE macro instruction to obtain the logon message.

**logon mode.** A set of *session parameters*.

**logon mode name.** A one-to-eight byte representation of a logon mode (a set of *session parameters*). A logical unit can use a logon mode name by including it in the LOGMODE portion of a logon command, and an application program can use a logon mode name by including it in the LOGMODE operand of an OPNDST or INQUIRE macro instruction.

**logon mode table.** A table of macro-generated constants that associates a logon *mode name* with a set of *session parameters*.

**logon request.** A request by a terminal user to be connected to an application program.

**major node.** A set of minor nodes that are capable of being activated, deactivated, and displayed as a group. Major nodes must consist entirely of one of the following five types of minor nodes: application programs, locally attached 3270 terminals, locally attached 3790 terminals, remotely attached SNA terminals on switched links, or terminals defined to an NCP (SDLC terminals on leased links, BSC terminals, and start-stop terminals). The minor node definition statements that form the major node are filed together as a member of a VTAM definition data set; the name of the major node is the name used to file the definition statements and to activate and deactivate the major node.

**message.** In VTAM, a single transmission of information between VTAM or a VTAM application program and an SNA terminal. A message contains data, or information that controls the exchange of messages and responses, or both data and control information.

**minor node.** In VTAM, an element of the telecommunication network that is capable of being activated or deactivated by the VARY command. Included among minor nodes are: locally attached 3270 terminals; locally attached 3790 physical units and logical units; remotely attached physical units, logical units, BSC terminals, and start-stop terminals; application programs; NCP lines and line groups. Each minor node is defined by a definition statement or macro instruction, and the name of each minor node is the label of the definition statement or macro instruction.

**NCP.** Same as NCP/VS. See *network control program*.

**NCP/VS.** Network control program/virtual storage. See *network control program*.

**NCP generation.** See *network control program generation*.

**network control program (NCP).** A program, transmitted to and stored in a communications controller, that controls the operation of the communications controller.

**network control program generation.** The process, performed in a host CPU, of assembling and link-editing a macro instruction program to produce a network control program.

**network definition.** The process of defining, to VTAM, the identities and characteristics of each device and application program in the telecommunication network and their arrangement in the network.

**network operator.** The person responsible for controlling the telecommunication network.

**network operator command.** In VTAM, a command used by the network operator to monitor or control the telecommunication network.

**network operator console.** The system console from which a network operator controls a telecommunication network.

**NIB.** Node initialization block.

**NIB list.** A series of contiguous NIBs (node initialization blocks).

**node initialization block (NIB).** A control block associated with each terminal at the time it is connected. The node initialization block contains information used by a VTAM application program to identify the terminal and to indicate to VTAM how communication with the terminal is to be done.

**path.** The intervening nodes and lines connecting a terminal with a VTAM application program in the host CPU.

**physical unit. (SNA)** (1) The control unit or cluster controller of an SNA terminal (for example, the 3601 Finance Communication Controller of a 3600 Finance Communication System, or the control unit of a 3767 Communication Terminal). (2) The part of the control unit or cluster controller that fulfills the role of a physical unit as defined by Systems Network Architecture (for example, the part of the cluster controller that controls SSCP-LU sessions or that handles recovery and resynchronization after a failure of a data link).

**record mode.** The facilities (and the macro instructions needed to use them) that enable the application program to communicate with logical units or with locally or remotely attached 3270 Information Display System terminals.

**remote.** Pertaining to terminals and communications control units that are attached to a central computer through a communications control unit. Contrast with *local*.

**request parameter list (RPL).** A control block that contains the parameters necessary for processing a request for data transfer or a request for connecting or disconnecting a terminal or other operation.

**response.** The unit of information that is exchanged between VTAM or a VTAM application program and an SNA terminal to describe how a message arrived.

**RPL.** Request parameter list.

**SDLC.** Synchronous data link control.

**session. (SNA)** A state during which two elements of the network can communicate with each other.

**session parameter. (SNA)** One of the set of characteristics, rules, or protocols that is specified when beginning a session between a VTAM application program and an SNA terminal. Session parameters determine such things as (1) what kinds of responses are allowable to messages that are sent, (2) whether a change-direction half-duplex protocol is to be used to take turns sending and receiving, and (3) whether one message must be responded to before another message can be sent. A logon request can specify a set of session parameters (a *logon mode*). Similarly, a VTAM application program can be the selector of the set of session parameters. Also see *logon mode name*.

**shared.** (1) Pertaining to communication control units and communication lines that may be used concurrently by several

teleprocessing programs to communicate with different devices. (2) Pertaining to terminals that may be used by more than one teleprocessing program; only one teleprocessing program may be connected to a shared terminal at any one time.

**SNA.** Systems Network Architecture.

**SNA terminal.** In VTAM: (1) An SNA physical unit or logical unit. (2) A terminal designed to be compatible with Systems Network Architecture (SNA). For example, the 3790 Communication System is a product whose terminals (relative to VTAM) are compatible with SNA. In addition to SNA terminals, VTAM also supports local 3270, start-stop, and BSC terminals.

**solicit.** To invite a terminal to send data. Soliciting encompasses the initialization of the terminal if necessary, as well as polling. When a terminal is solicited, data is transferred to and held by VTAM to await transfer to an application program.

**start options.** The installation-specified (or defaulted) options that determine certain conditions that are to exist during the time that a VTAM system is operating. These options include: the size of VTAM storage pools, which major or minor nodes are to be traced by the VTAM trace facility, and which major nodes are to be made initially active. Start options can be predefined or specified by the network operator when VTAM is started.

**start-stop transmission.** Asynchronous transmission in which each group of code elements corresponding to a character signal is preceded by a start signal which serves to prepare the receiving mechanism for the reception and registration of a character, and is followed by a stop signal which serves to bring the receiving mechanism to rest in preparation for the reception of the next character.

**synchronous data link control (SDLC).** A discipline for the management of information transfer over a communications channel. Transmission exchanges may be full-duplex or half-duplex; the communications channel configuration may be point-to-point, multipoint, or loop. SDLC includes comprehensive detection and recovery procedures, at the data link level, for transmission errors that may be introduced by the communication channel.

**Systems Network Architecture (SNA).** The total description of the logical structure, formats, protocols, and operational sequences for transmitting information units through the communication system. Communication-system functions are separated into three concrete areas: the application layer, the function management layer, and the transmission subsystem layer. The structure of SNA allows the ultimate origins and destinations of information (the end users) to be independent of, and unaffected by, the specific communication-system services and facilities used for information exchange.

**switched line.** A communication line in which the connection between the computer and a remote station is established by dialing.

**telecommunication network.** In a telecommunication system, the combination of all terminals and other telecommunication devices and the lines that connect them.

**telecommunication system.** In a teleprocessing system, those devices and functions concerned with the transmission of data between the central processing system and the remotely located users. In VTAM, the telecommunication system includes the *host CPU*, *VTAM application programs*, *VTAM*, the *telecommunication network*, and the channels that link the host CPU and the network.

**teleprocessing subsystem.** In VTAM, a secondary or subordinate network (and set of programs) that is part of a larger teleprocessing system; for example, the combination consisting

of a programmable controller, its stored program, and its attached input/output devices. An example of a teleprocessing subsystem is the IBM 3600 Finance Communication System.

**teleprocessing system.** The devices and functions of a data processing system that give users at remote locations access to the data processing capabilities of a centrally located computer. A teleprocessing system has two major functions, the transmission of data between the central computer and the remote locations (performed by the telecommunication system) and the actual processing of the data in the central computer.

**terminal.** (1) To VTAM, an end point in a telecommunications network; that is, a physical unit, a logical unit, or a local 3270, start-stop, or BSC device. (2) Relative to a VTAM application program, a logical unit or local 3270, BSC, or start-stop device.

**transmission.** In data communication with start-stop and BSC terminals, a logical group of one or more blocks or messages. A transmission is terminated by an EOT character. See also *block* and *message*.

**transmission control unit.** A type of communication control unit whose operations are controlled solely by programmed instructions from the system to which the unit is attached; no program is stored or executed in the unit. Contrast with *communications controller*.

**unconnected terminal.** An active terminal that is not connected to an application program.

**Virtual Telecommunications Access Method (VTAM).** An IBM program that controls communication between terminals and application programs running under DOS/VS, OS/VS1, and OS/VS2.

**VTAM.** Virtual Telecommunications Access Method.

**VTAM application program.** (1) To VTAM, the requests and control blocks that refer to a given ACB, or are pointed to by that ACB. (2) To the programmer, the set of instructions that performs a given function, including the processing of the input and output data. One set of instructions may refer to more than one ACB.

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