

GC30-3033-1  
File No. S370-30

**Program Product**

**Introduction to  
Advanced Communications  
Function**



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Advanced Communications  
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## Second Edition (May 1979)

This is a major revision of, and makes obsolete, GC30-3033-0. This edition applies to:

- ACF/TCAM, Version 2, Releases 1, 2, and 3 (Program No. 5735-RC3 [OS/VS1 and OS/VS2 (MVS)])
- ACF/VTAM, Releases 2 and 3 (Program Nos. 5735-RC2 [OS/VS1 and OS/VS2 (MVS)], 5746-RC3 [DOS/VS])
- ACF/NCP/VS, Releases 2 and 3 (Program No. 5735-XX1)

and to all subsequent versions and releases unless otherwise indicated in new editions or Technical Newsletters.

The Summary of Changes page describes the changes in this edition. Much of the material in the previous edition has been revised and reorganized and the present edition should be reviewed in its entirety.

Changes are periodically made to the information herein; before using this publication in connection with the operation of IBM systems, refer to *IBM System/370 Bibliography*, GC20-0001, for the editions that are applicable and current.

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## Preface

This publication introduces the types of System/370-based data communication networks<sup>1</sup> whose operation is managed by programming components of Advanced Communications Function: ACF/TCAM (Advanced Communications Function for Telecommunications Access Method), ACF/VTAM (Advanced Communications Function for Virtual Telecommunications Access Method), and ACF/NCP/VS (Advanced Communications Function for Network Control Program/Virtual Storage). This publication is directed primarily to data processing managers and network designers who may want to install or upgrade a network or consolidate existing networks.

ACF/TCAM, ACF/VTAM, and ACF/NCP/VS are licensed program product versions of TCAM, VTAM, and NCP/VS, which are system control programs (SCP). The program product versions contain significant enhancements to the SCP versions.

The general term *SNA-based network* as used in this publication represents a network that is managed and controlled by programming components designed in accordance with the IBM Systems Network Architecture (SNA). SNA-based networks may include stations that are not designed in accordance with SNA as well as those that are so designed.

This publication is organized into five chapters and two appendixes:

- Chapter 1 introduces Advanced Communications Function and its purpose, and introduces the concept of network domains.
- Chapters 2 and 3 describe networks as supported by ACF/TCAM, Version 2, Release 2; ACF/VTAM, Release 2; and ACF/NCP/VS, Release 2. These programs are collectively referred to in this publication as *Level 2* of ACF.

Chapter 2 describes the components and characteristics of a single-domain network that uses ACF/TCAM or ACF/VTAM as the access method and ACF/NCP/VS to control data flow to and from remote stations in the network.

Chapter 3 describes how two or more networks can be interconnected to form a multiple-domain network in which the network resources in one domain can be shared by other domains.

- Chapter 4 introduces the added capabilities that will be available in ACF/TCAM, Version 2, Release 3; ACF/VTAM, Release 3; and ACF/NCP/VS, Release 3. These programs are collectively referred to in this publication as *Level 3* of ACF. These capabilities can improve the efficiency and reliability of SNA-based networks and can make them easier to install and use.
- Chapter 5 contains preinstallation planning information in the form of questions to be answered by the installation manager (or other individual responsible for planning the development of an SNA-based network) during the preinstallation phase of the project.
- Appendix A lists the communication products supported by *Level 3* of ACF.
- Appendix B is a glossary of terms and abbreviations.

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<sup>1</sup>The term *network* has at least two meanings. A *public network* is a network established and operated by common carriers or telecommunication Administrations for the specific purpose of providing circuit-switched, packet-switched, and leased-circuit services to the public. A *user application network* is a configuration of data processing products, such as processors, controllers, and terminals, established and operated by users for the purpose of data processing or information exchange, which may use transport services offered by common carriers or telecommunication Administrations. *Network* as used in this publication refers to a user application network.

Both ACF/VTAM and ACF/TCAM accommodate a large variety of network resources (terminals, cluster controllers, communications controllers, and processors) in networks of various sizes and degrees of complexity. This publication does not compare the facilities provided by the access methods; rather, it stresses the capabilities that these access methods, in combination with ACF/NCP/VS, bring to data networks. The choice of which access method to use depends on the requirements of the applications for which the network is to be used. Some networks may require both access methods. See the publications *ACF/TCAM General Information: Introduction*, GC30-3057, and *ACF/VTAM General Information: Introduction*, GC27-0462, for details of these access methods.

Prerequisite to use of this publication is a general knowledge of data communication and the concepts of Systems Network Architecture (SNA). Information on these subjects can be found in the publications listed under "Prerequisite Publications."

**Note:** In this publication, groups of digits are separated by a space rather than a comma (for example, 32 768 instead of 32,768).

### Prerequisite Publications

*Systems Network Architecture General Information*, GA27-3102  
*Introduction to Data Communication Systems*, SR20-4461

### Related Reading

*ACF/VTAM General Information: Introduction*, GC27-0462  
*ACF/TCAM General Information: Concepts*, GC27-0463  
*ACF/TCAM General Information: Introduction*, GC30-3057  
*ACF/TCAM General Information: Functional Description*, GC30-3131  
*ACF/NCP/VS (Network Control Program and System Support Programs) General Information*, GC30-3058  
*Network Operation Support Program General Information*, GC38-0251  
*Network Communications Control Facility General Information*, GC27-0429  
*Network Problem Determination Application General Information*, GC34-2010  
*Programmed Cryptographic Facility General Information*, GC28-0942

### Summary of Changes

In this second edition, Chapters 1, 2, and 3 correspond to the Introduction, Part 1, and Part 2 of the first edition. These chapters now include the single-domain and multiple-domain facilities afforded by ACF/TCAM, Version 2, Releases 1 and 2; ACF/VTAM, Release 2; and ACF/NCP/VS, Release 2.

Chapter 4 contains entirely new material describing the significant new capabilities and functions of ACF/TCAM, Version 2, Release 3; ACF/VTAM, Release 3; and ACF/NCP/VS, Release 3. These versions and releases, collectively referred to as *Level 3* of Advanced Communications Function, can improve the reliability, availability, and usability of SNA-based networks.

Chapter 5 is a new chapter that suggests some preinstallation planning considerations for users intending to install or upgrade a SNA-based network.

Appendix A now lists the communication products supported by Level 3 of ACF; Appendix B contains a glossary of terms and abbreviations. The former Appendix B, containing information on the Network Operation Support Program, is deleted.

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## Chapter 1. Introduction

This chapter briefly introduces Advanced Communications Function and summarizes the host processor and communications controller requirements for use of ACF/VTAM, ACF/TCAM, and ACF/NCP/VS—constituent parts of Advanced Communications Function.

### *What is Advanced Communications Function?*

Advanced Communications Function is a group of IBM licensed program products that use the concepts of the IBM Systems Network Architecture and the capabilities of products, such as the IBM 3705 Communications Controller and IBM data communication products, to accommodate online applications in networks of various sizes and degrees of complexity.

The principal program products for Advanced Communications Function are:

- ACF/VTAM (Advanced Communications Function for Virtual Telecommunications Access Method)
- ACF/TCAM (Advanced Communications Function for Telecommunications Access Method)
- ACF/NCP/VS (Advanced Communications Function for Network Control Program/Virtual Storage)

These program products represent significant improvements to TCAM, VTAM, and NCP/VS, which are the system control programming (SCP) equivalents.

ACF/TCAM, ACF/VTAM, and ACF/NCP/VS permit a network designer considerable flexibility in the design and installation of single-processor and multiple-processor networks. These networks can take advantage of such SNA capabilities as sharing of network resources, distributed function, device independence, and flexibility of network configuration. These capabilities, and others, are introduced in this publication.

Some of the key features of Advanced Communications Function are:

- Continuous growth potential to meet customer requirements: from small single-processor networks to larger ones; and from separate single-processor networks to a consolidated, multiple-processor network.
- Multiple channel attachment support: Up to four channel adapters (3705-II) or up to two channel adapters (3705-I) in a 3705 allows the ACF/NCP/VS to communicate concurrently with up to four (or up to two) access methods in one or more attached host processors. The failure of one host processor does not affect the network control program's ability to communicate with the remaining host processors.
- Capability to minimize data congestion in a network by controlling the rate at which the network control program and access methods accept data from stations in the network.
- Improved techniques for controlling a network and for determining problems in the network.
- Cross-domain message routing: (1) data can flow directly between adjacent network control programs (that is, network control programs joined by an SDLC link); (2) data can flow from an SNA station (and from certain types of non-SNA stations) to an access method in a domain other than the one in which the station resides, without involvement of the access method that manages the station's domain; and (3) data can flow through an intermediate ACF/NCP/VS in the path between a station and an application program without involvement of the access method for the domain to which the ACF/NCP/VS belongs.

- Improved network availability resulting from the ability of an ACF/NCP/VS to maintain SNA sessions on nonswitched SDLC links despite failure of the attached host processor and the ability to continue to perform its cross-domain message routing functions.
- A choice of access methods: ACF/VTAM and ACF/TCAM.
- Compatibility with existing application programs that use the non-ACF versions of TCAM and VTAM.
- Coexistence, within a consolidated network, of ACF/TCAM and ACF/VTAM, as well as other access methods such as BTAM (Basic Telecommunications Access Method).

## Related ACF Program Products

In addition to ACF/VTAM, ACF/TCAM, and ACF/NCP/VS—the major components of Advanced Communications Function—several other program products are available to help in controlling a network and diagnosing problems that occur.

*Network Operation Support Program (NOSP):* The process of controlling a complex multiple-domain network can be simplified by use of an IBM program product, Network Operation Support Program. This program, available for ACF/VTAM users in Level 1 and Level 2 of Advanced Communications Function, routes ACF/VTAM and system commands to the proper domain for execution and routes the responses from that domain back to the operator who issued the commands. NOSP provides for multiple network operators to communicate with each other through the network and also permits user-written programs that react to data traffic or to user-written commands to be added to the network. For information on NOSP, see the publication *Network Operation Support Program General Information*, GC38-0251.

*Network Communications Control Facility (NCCF) and Network Problem Determination Application (NPDA):* These program products can be used with ACF/TCAM and ACF/VTAM to control a SNA-based network and to identify, isolate, and monitor errors that occur within the network and to record them in a central location. For information about these program products, see *Network Communications Control Facility General Information*, GC27-0429, and *Network Problem Determination Application General Information*, GC34-2010.

## Extendable Data Communication Facilities

VTAM and TCAM (in their non-ACF versions) enable application programs to communicate with a large variety of stations (terminals, controllers, processors, etc.). Either of these access methods offers the following general services:

- Establish, terminate, and control access of application programs to stations and of stations to application programs.
- Transfer data between application programs and stations.
- Permit application programs to share communication lines, communications controllers, and stations, thus improving the flexibility of network configurations and possibly reducing the number of communication lines and stations required in a network.
- Permit the operation of the network to be monitored and altered as necessary to meet changing conditions.

With some limited exceptions, not described here, the non-ACF versions of VTAM and TCAM permit only single-processor network configurations. That is, a single copy of the access method (TCAM or VTAM) can reside in the operating system for each host processor (System/370) in a network. This single-processor configuration is referred to as a *single-domain* network. Chapter 2 describes single-domain networks.

ACF/TCAM and ACF/VTAM can support a multiple-processor network, referred to as a *multiple-domain* network, in addition to supporting single-domain networks. A multiple-domain network allows application programs and stations in one domain to communicate with application programs in other domains by means of cross-domain connections. A domain consists of all of the resources, such as terminals and communication lines, that are controlled by an access method in a single host processor. Each domain in a multiple-domain network must contain either ACF/VTAM or ACF/TCAM as the access method that controls the domain. A multiple-domain network allows network resources to be shared among two or more interconnected domains—a concept known as *networking*. Networking requires a feature called Multisystem Networking Facility (MSNF), available for both ACF/TCAM and ACF/VTAM. Multiple-domain networks and networking are described in Chapter 3.

Both ACF/VTAM and ACF/TCAM use the facilities of ACF/NCP/VS (executed in an IBM 3705 Communications Controller) to communicate with remote stations in *network control mode*. When operating lines and stations in this mode, ACF/NCP/VS is performing for the access method those network control services for which the ACF/NCP/VS and the communications controller are principally designed.

ACF/TCAM (but not ACF/VTAM) can also use the ACF/NCP/VS with the partitioned emulation programming extension (an option within ACF/NCP/VS) to control lines and stations in *emulation mode*. When operating lines and stations in emulation mode, ACF/NCP/VS emulates the functions of an IBM 2701 Data Adapter Unit or a 2702 or 2703 Transmission Control, or a combination of these units. The publication *ACF/NCP/VS (Network Control Program and System Support Programs) General Information*, GC30-3058, contains more information on the use of emulation mode.

The IBM facilities for Advanced Communications Function accommodate both single-domain and multiple-domain networks. Five separate facilities provide discrete functional capabilities:

- ACF/VTAM
- ACF/VTAM Multisystem Networking Facility (an optional feature)
- ACF/TCAM
- ACF/TCAM Multisystem Networking Facility (an optional feature)
- ACF/NCP/VS

ACF/TCAM and ACF/VTAM also provide support for the Cryptographic program product for users whose application requirements include the need for assuring the security of data flowing through a network. The support is standard in ACF/TCAM and separately orderable, as the Encrypt/Decrypt feature, in ACF/VTAM. The access method support, in combination with the program product, allows users to establish, control, and terminate access to stations and application programs with cryptographic sessions in which data requiring high security is enciphered when entering the network and deciphered when leaving the network. Information on the access method support may be found in *ACF/VTAM General Information: Concepts*, GC27-0463, and *ACF/TCAM General Information: Functional Description*, GC30-3131. Information on the program product may be found in *Programmed Cryptographic Facility General Information*, GC28-0942.

Because this publication describes the network configurations that are possible with ACF/TCAM, ACF/VTAM, and ACF/NCP/VS, the host processor for the single-domain networks is assumed to contain either ACF/TCAM or ACF/VTAM. For the multiple-domain networks, each host processor must contain either ACF/TCAM or ACF/VTAM and the Multisystem Networking Facility for ACF/TCAM or ACF/VTAM, as appropriate.

The communications controllers must contain ACF/NCP/VS. The program requirements in ACF/NCP/VS are independent of whether ACF/TCAM or ACF/VTAM is to be used in the host processor, or whether ACF/NCP/VS is to be used in a single-domain or a multiple-domain network.

### ***Host Processor Requirements***

ACF/VTAM and ACF/TCAM are executed in one of the following processing units:

- Under OS/VS1: System/370 (any model that supports OS/VS1)
- Under OS/VS2: System/370 (any model that supports OS/VS2 MVS)
- Under DOS/VS or DOS/VSE (ACF/VTAM only): System/370 (any model that supports DOS/VS or DOS/VSE)

The processing units must have the Compare and Swap and the Compare Double and Swap instructions in their instruction sets.

### ***Communications Controller Requirements***

ACF/NCP/VS can be executed in either the IBM 3705-I or 3705-II Communications Controllers. However, certain network configurations and capabilities described in this publication are dependent on hardware options available only in the 3705-II controller. The terms *3705 communications controller*, *3705*, and *communications controller* are used to mean either the 3705-I or 3705-II.

### ***Stations Supported***

Advanced Communications Function accommodates two categories of stations: *SNA stations* and *non-SNA stations*. SNA stations can perform functions defined by Systems Network Architecture (SNA). When attached to a network connected to a 3705 communications controller, SNA stations use the SDLC (synchronous data link control) line discipline. Some types of SNA stations can be directly attached to a host processor channel and directly controlled by ACF/TCAM or ACF/VTAM.

Non-SNA stations include those using the start-stop and binary synchronous (BSC) line control disciplines as well as some stations, such as the IBM 3270 Information Display System, that can be directly attached to a host processor and directly controlled by ACF/TCAM or ACF/VTAM. SNA and non-SNA stations are described under "Systems Network Architecture" in Chapter 2.

Appendix A lists the types of stations and systems that can be remotely attached (via links) and locally attached (via host processor channel) to a network controlled by Advanced Communications Function.

### ***Network Terminal Option***

ACF/VTAM supports some non-SNA stations through the Network Terminal Option program product. (Appendix A indicates which non-SNA stations require the Network Terminal Option.) This option allows these stations to be attached to the network as SNA logical units; ACF/VTAM then supports these stations as IBM 3767 Communication Terminals. For information about this option, see *Network Terminal Option General Information*, GC38-0297.

## *Programming Subsystems*

ACF/TCAM and ACF/VTAM can communicate with numerous IBM programming subsystems such as CICS/VS (Customer Information Control System/Virtual Storage) and IMS/VS (Information Management System/Virtual Storage). See the publication *ACF/VTAM General Information: Introduction*, GC27-0462, or consult your IBM representative for the subsystems supported by ACF/VTAM. See the publication *ACF/TCAM General Information: Introduction*, GC30-3057, or consult your IBM representative for the subsystems supported by ACF/TCAM.



## Chapter 2. ACF Level 2 Facilities for a Single-Domain Network

This chapter introduces some general concepts of Systems Network Architecture (SNA) as represented in the design of ACF/VTAM, ACF/TCAM, and ACF/NCP/VS; explains what a single-domain network is; and defines some terms frequently used in discussing SNA-based networks.

Regardless of the data processing application for which it is installed, a network of the kind this publication describes is a system of interconnected terminals, controllers, and processing units used to transmit information between locations in the network. At various points in the network the information may be processed or its form changed, as dictated by application requirements.

Figure 2-1 shows an example of a simple network having each of the kinds of elements typically found in System/370-based networks: a host processor (the System/370), an IBM 3705 Communications Controller, a group of terminals and the shared controller (called a cluster controller) that links them to the 3705, and two terminals directly linked to the 3705. In this simple network that Figure 2-1 illustrates:

- The host processor (A) contains (in part) an operating system, a communication access method, application programs, and logical units that represent the application programs to the network. (In this publication, *access method* always refers to a communication access method: ACF/TCAM or ACF/VTAM, or their non-ACF equivalents.) The access method supervises the operation of the network and interacts with the network control program in the communications controller to transmit message traffic between the host processor and the network.
- The communications controller (B), executing a network control program, manages the details of line control and routing of data through the network. The program can route data to the host processor and can route data to and from the cluster controller (C) or a terminal (D). (In a typical network the communications controller would route data to and from many cluster controllers, terminals, and other communications controllers.)
- The cluster controller (C) and the terminals (D) each attach one or more input/output units to the network. Cluster controllers and terminals differ primarily in the amount of processing capability they have and in the complexity of their configurations. Cluster controllers and terminals are mainly concerned with fulfilling application requirements rather than with performing network routing and control functions.
- The ultimate source or destination of information flowing in the networks is called an end user (E). End users may be individuals such as terminal operators, physical device media such as tapes or cards, or application programs. End users are not identified as such to the network; they gain access to the network and its resources through logical units (F). Logical units are assigned names that uniquely identify them to the network elements (access methods and network control programs) responsible for routing message traffic through the network.

### *Single-Domain and Multiple-Domain Networks*

The term *single domain* applies to a network that has a single controlling point, which is located in the access method that manages the network. SNA-based networks that result from consolidating previously separate networks will frequently have more than one controlling point (access method), each responsible for a portion of the network called a *domain*. Or a single network may be designed from the beginning, or later modified, to have multiple controlling points as a means of realizing the distribution of function that is a primary objective of Systems Network Architecture. In either case, if elements of

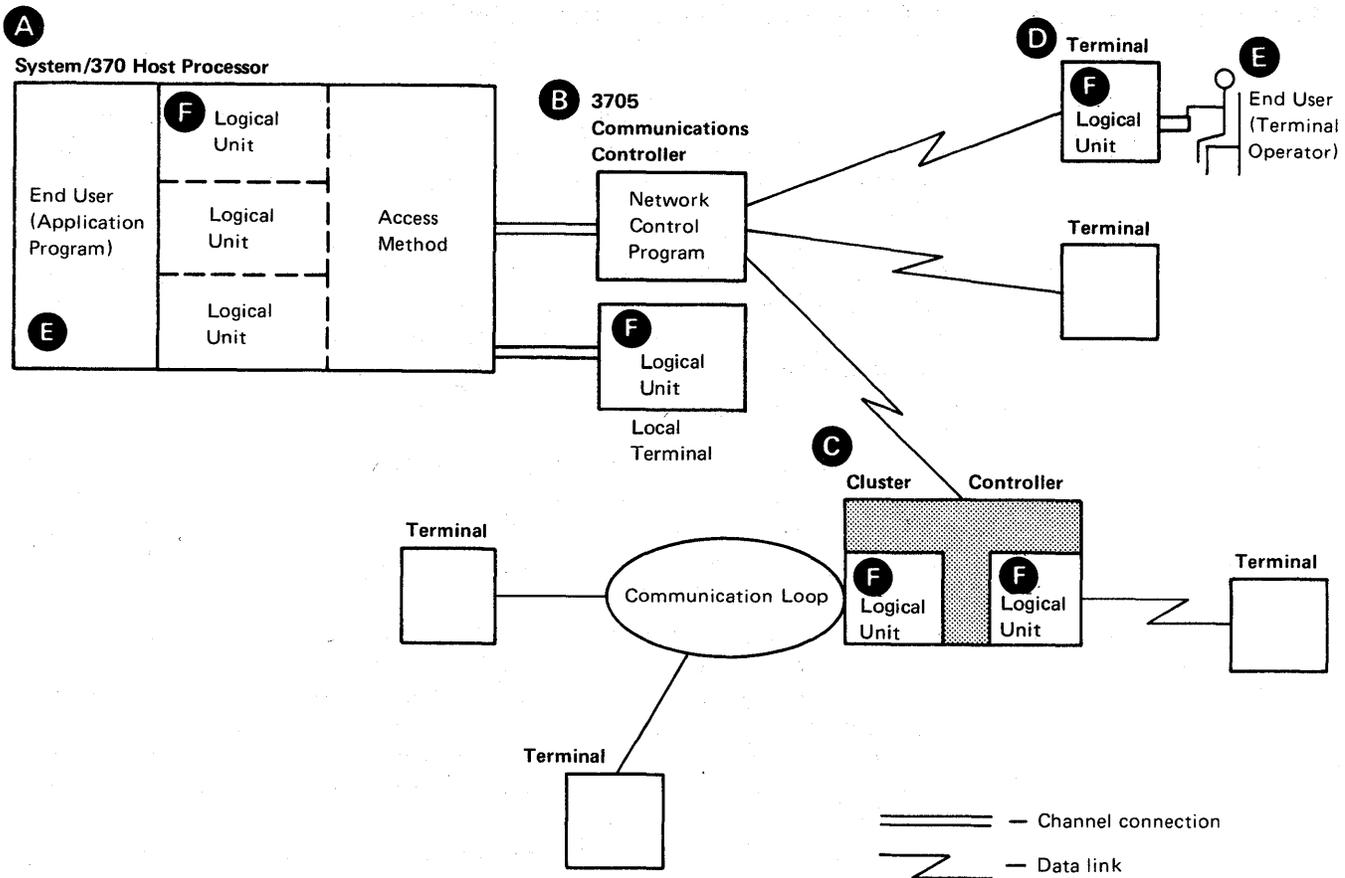


Figure 2-1. Elements of an SNA-Based Data Communication Network

one domain (such as stations and application programs) can communicate with elements of another domain via cross-domain communication, the entire network is called a *multiple-domain network*. If a network has more than one domain but there is no cross-domain communication, the result in effect is multiple single-domain networks.

### Distributed Function

An important concept of current network design is that of *distributed function*. This concept is the idea that processing of data can be done at many points in the network, rather than only at a central site. Some devices in the network can be programmable, thus allowing functions that were previously done at a central site to be performed instead at other locations in the network. Distributing function can be advantageous to users of a network in several ways.

*Improved response time:* In networks in which function is not distributed, each interactive message (request) must be forwarded to the host processor and a response returned to the originator of the message. The response could be slow in returning if the request and response travel at slow speeds (due to low transmission rates or the need for repeated retransmissions to recover from line errors) and/or the host processor has a heavy processing load. If, in contrast, some processing functions are moved closer to the point at which requests originate, then the response time may be improved because the requests and responses travel over shorter paths and request processing is unaffected by heavy loads at the host processor. Appropriate distribution of function, together with effective systems design, can be an important factor in assuring adequate response times in the network.

*High Availability:* In a network without distributed function, a host processor failure may incapacitate the entire network for as long as the host is not available, unless a backup processor can be substituted for the inoperative processor. In a network with distributed function, proper application design can allow programmable stations and cluster controllers to continue to operate effectively even when the host processor or communication line fails. Distributed function can also increase availability of the network by giving each network component some capability for error recovery.

*Less Duplication of Effort:* In networks without distributed function, frequently the only backup capability when communication is interrupted is manual handling of transactions at the remote location. When communication with the host processor is reestablished, the transactions have to be reentered in order to be permanently stored in the system. However, with distributed function, transactions that take place while the host processor or communication line is inoperative can be stored on an input/output storage device (if present) at the remote location for later transmission to the central site, thus eliminating duplicate operator effort.

### ***Resource Sharing***

*Resource sharing* is an important concept that allows the users of a network to share such resources as application programs, network control programs, and communication facilities. For example, stations attached to the same communication facility can be connected to different application programs. When an application program requests data transfer, the communication facility is used. Thus, the communication facility is shared among the stations and the application programs.

### ***Communication Facilities in a Network***

Data transferred between elements of the network is transmitted by means of *communication facilities*, which can be either switched, nonswitched, or a combination of the two.

A *nonswitched* communication line (also called a *link*) connects the communications controller to the stations on the line for either continuous or recurring periods. A nonswitched line is *point-to-point* if it connects the controller to a single remote station and *multipoint* if it is capable of connecting the controller to more than one station.

A *switched* communication network establishes a temporary connection between a communications controller (or computer) and a remote station upon demand by the user. As in a telephone network, the actual path for a given transmission is not fixed but is automatically selected from a number of possible paths by telephone-switching equipment. A switched line is *point-to-point*, since only one remote station on a line may be connected during a given call. Dialing can be performed at the host processor, communications controller, cluster controller, or at a remote station; the called station can answer either manually or automatically. Not all of these options are available for all types of line configurations and remote stations, or in all countries.

### ***Systems Network Architecture***

IBM's Systems Network Architecture (SNA) implements the concepts of distributed function among the physical components of a network and the sharing of resources among the users of the network. SNA is a design solution for a total network; it is an architecture that, when used in the design of devices and programs, allows application programs to be independent of devices and device attachments.

SNA-based networks accommodate a variety of SNA and non-SNA stations (terminals, cluster controllers, communications controllers and computers). An *SNA station* is capable of performing functions defined by the architecture. If the station is a terminal directly attached to the network, a logical unit within the terminal represents the terminal to the network control program and the access method. If the station consists of a cluster controller and one or more attached terminals, logical units within the cluster controller represent the terminals to the network control program and the access method.

A *non-SNA station* uses the start-stop or binary synchronous (BSC) line discipline to communicate with the host processor. These stations do not have logical units, but the host processor and the communications controllers perform the functions that are necessary to communicate with these devices in an SNA-based network.

### *Network Addressable Units*

The origins and destinations of information units flowing in an SNA-based network are called *network addressable units* (NAU). Any transfer of information within the network involves an origin NAU and a destination NAU that are formally bound to each other during the information transfer. The duration of this association between a pair of NAUs is called a *session*.

SNA defines three types of NAUs:

- *System services control point (SSCP)*: The SSCP is responsible for the general management of the network, such as bringing up the network, establishing sessions, or recovering when a network component fails to maintain contact.
- *Physical unit (PU)*: Each resource in the network (host processor, communications controller, cluster controller, SNA terminal) that has been defined to the SSCP is associated with a physical unit. (Communications controllers provide physical unit services for certain nonprogrammable and non-SNA stations.)
- *Logical unit (LU)*: A logical unit is the port through which the end user gains access to the services of the network. One or more logical units can be associated with a physical unit.

### *Network Resources*

The essential characteristic of an SNA domain is the existence of a control function in the access method called the *system services control point* (SSCP), identified earlier as one of the network addressable units. The SSCP is responsible for the general management of the network, and a *domain* is the set of resources in the network that is known to and managed by the SSCP.

Each resource in the domain is identified to the SSCP by a unique symbolic name assigned by the system programmer to that resource when the access method and the network control program are defined. All references by end users (operators and application programs) to resources are by resource name. Thus the end user need not be concerned about the location of the resource in the network nor with the path the SSCP and the network control program establish to reach that resource.

The access method uses internal tables to translate each reference to a resource name into a *network address*. This address has two parts: a subarea address and an element address (somewhat analogous to the exchange digits and the remaining digits that make up a local telephone number). Each network control program in a network is assigned a unique subarea address by the system programmer. Each resource directly controlled by that network control program is automatically assigned an element address. A subarea thus constitutes the network control program and all of the resources (elements) that that network

control program directly controls. Similarly, a unique subarea address is assigned to each access method (ACF/TCAM or ACF/VTAM) in the network. Local (channel-attached) stations and host logical units assume the subarea address of the access method that controls them.

## *SNA Sessions*

Before information can flow between network addressable units (NAUs), the access method must determine which pair of NAUs is to communicate and must establish a session between them. Sessions can exist between:

- The SSCP and a physical unit (SSCP-PU session).

The SSCP-PU session is used to communicate commands or requests to change the status of the network, information that reports the status of the network, and hardware test requests and results.

- The SSCP and a logical unit (SSCP-LU session).

The SSCP-LU session is used to communicate (1) requests from the logical unit to begin or end an LU-LU session and (2) operator commands entered at a station.

- Two logical units (LU-LU session).

The LU-LU session allows a pair of end users (two application programs or a station operator and an application program) to exchange data and to control the flow of the data. At least one of the LUs in a LU-LU session must be a host LU.

## *Single-Domain Network Configuration*

As stated earlier, a single-domain network is a network having a single controlling point, called the *system services control point* (SSCP). The SSCP is located in the access method, either ACF/TCAM or ACF/VTAM. Figure 2-2 represents a single-domain network. It is single domain because it has a single access method and therefore a single SSCP. All application programs, stations, links, and physical and logical units belong to the domain. Although this configuration shows only one ACF/NCP/VS, a single-domain network can include more than one ACF/NCP/VS, each in its own 3705 communications controller.

Figure 2-3 shows a network configuration that includes three access methods and a single ACF/NCP/VS. The resources controlled by the network control program are divided among the access methods such that each access method communicates with only the resources in its domain. The access methods do not have the Multisystem Networking Facility, and therefore the resources in each domain cannot communicate with resources in another domain. Because there is, in this case, no cross-domain communication, this configuration is in effect divided into three single-domain networks. This is an example of multiple single-domain networks sharing the same ACF/NCP/VS. If, in contrast, cross-domain communication did exist, the configuration would constitute a multiple-domain network; such networks are discussed in Chapter 3.

Figure 2-2 shows a communications controller that is attached to a host processor by a data channel; a controller attached by a channel is called a local communications controller. Figure 2-3 shows a controller that is attached to three host processors by three data channels. Controllers can also be located remotely from a host processor; such controllers communicate with the host processor through an intervening local communications controller. The local and the remote controllers are connected by one or more SDLC links. Only one link may be operated between a local and a remote controller at any moment if either or both controllers are executing ACF/NCP/VS, Release 2 (a component of Level 2 of ACF). (Chapter 4, which introduces the ACF Level 3 functions, explains the simultaneous operation of links between communications controllers.)

Figure 2-4 shows a single-domain network containing two remote controllers and their attached stations as well as the local controller and its attached stations.

Because remote communications controllers need not be physically adjacent to the host processor, they can be placed nearer the stations they control, thus reducing the aggregate length of the communication lines to those stations. The reduction in line length may in some cases reduce line charges, which are a major portion of the cost of operating some networks.

A remote communications controller must be connected to a local controller by a duplex or half-duplex SDLC link called a *local-remote link*. Such links carry all of the message traffic exchanged between the access method and stations connected to the remote controller by SDLC, binary synchronous (BSC), and start-stop lines. The remote controller serves as a concentrator for message data from remote stations connected to it. A local-remote link is usually nonswitched, but it can instead be a manually dialed, switched link. In some configurations, it may be appropriate for the regular nonswitched link to be augmented by a switched backup link that can be substituted for the nonswitched link if the latter fails or must be temporarily deactivated.

A single-domain network can include multiple local and remote communications controllers. Multiple remote controllers can be connected to the same local controller, each by a separate local-remote link. A single remote controller cannot, however, communicate simultaneously with more than one local controller if any of the controllers is executing ACF/NCP/VS, Release 2. (Chapter 4 explains how multiple local controllers can communicate simultaneously with the same remote controller, if all controllers are executing ACF/NCP/VS Release 3.)

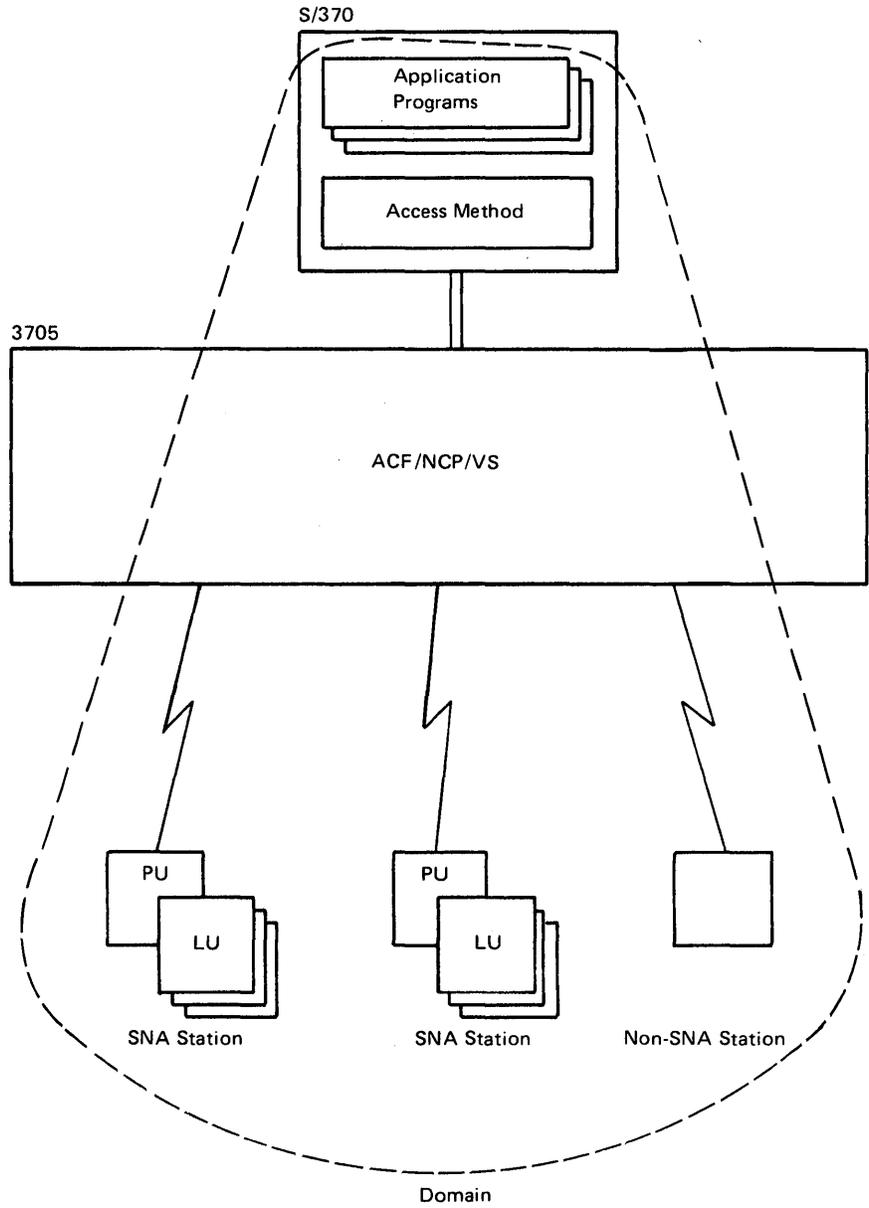


Figure 2-2. A Single-Domain Network Configuration

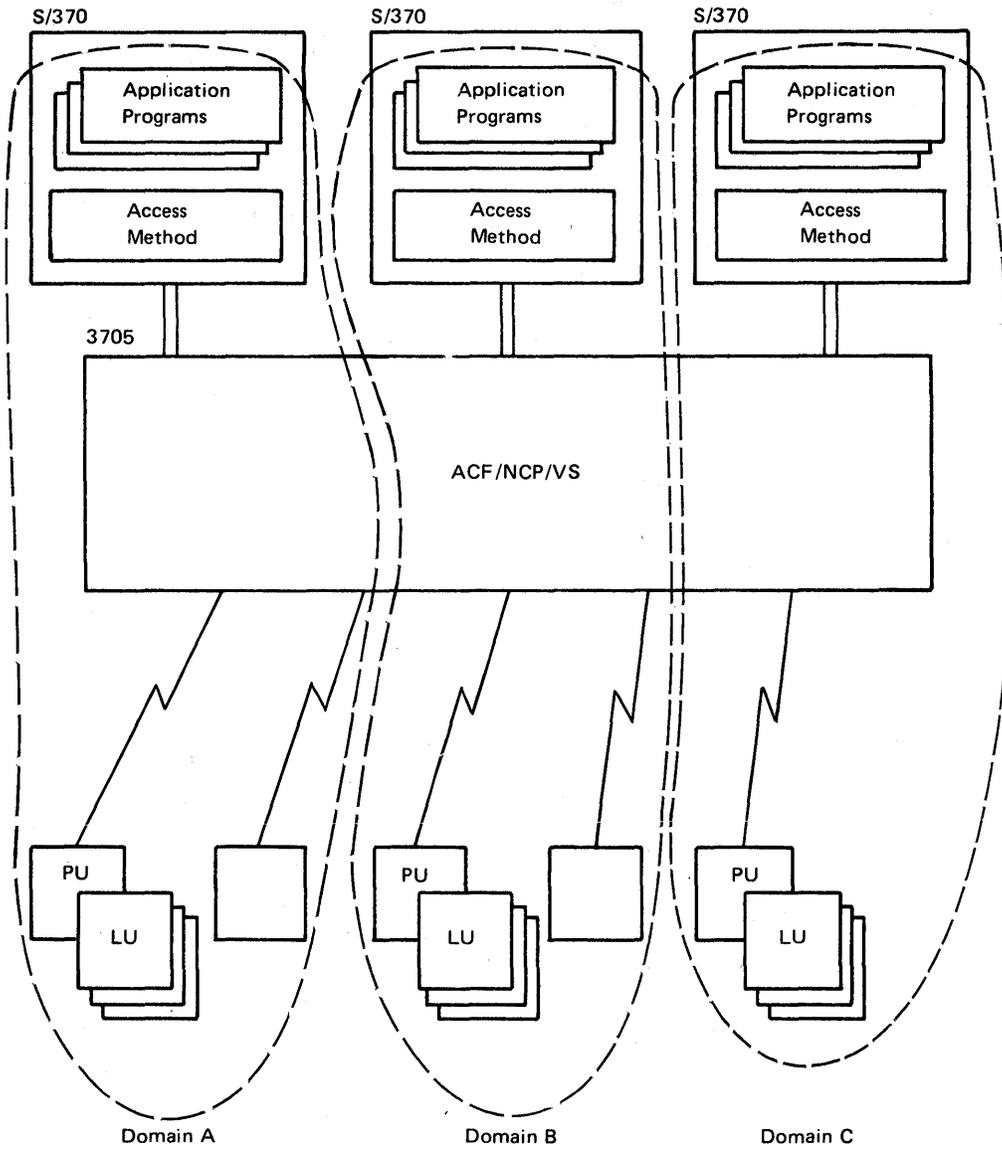


Figure 2-3. A Configuration of Multiple Single-Domain Networks

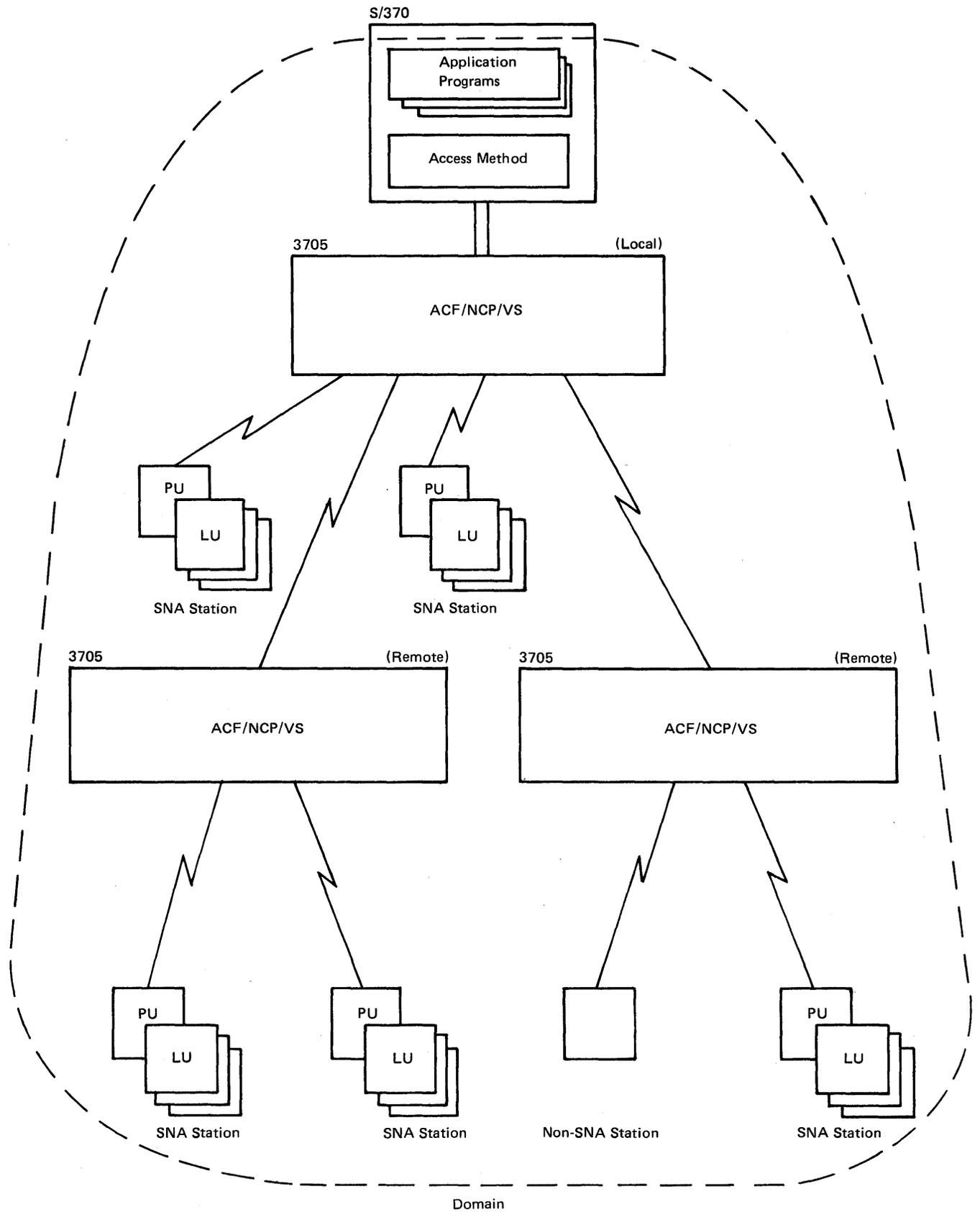


Figure 2-4. A Single-Domain Network Configuration with One Local and Two Remote Communications Controllers

## *Functions of ACF/NCP/VS*

ACF/NCP/VS (Advanced Communications Function for Network Control Program/VS) fulfills the concept of distributed function in SNA-based networks by performing many communication control functions that the access method in the host processor would otherwise have to perform. The functions of ACF/NCP/VS include:

- Controlling communication lines of various kinds (nonswitched, switched, SDLC, BSC, start-stop)
- Controlling dynamic buffering
- Activating, deactivating, and monitoring the status of communication lines on behalf of the access method
- Deleting and inserting communication control characters in message data as required
- Performing error-recovery actions for communication lines
- Gathering communication line statistics, including error statistics, and providing them to the access method on command
- Translating message data from processing code to transmission code, and vice versa, for start-stop and BSC lines

By performing these and other specialized communication control functions outside the host processor, ACF/NCP/VS can reduce the processing load on the host processor.

The functions listed above are those for which ACF/NCP/VS is principally designed. They are collectively called *network control functions*; communication lines and other network resources for which the program performs these functions are said to operate in *network control mode*. (See *ACF/NCP-SSP General Information*, for more information on network control functions.)

An ACF/NCP/VS to be executed in a local 3705 can be generated with the partitioned emulation programming (PEP) extension to allow *emulation mode functions* to be performed for user-specified communication lines. Such lines are said to operate in *emulation mode*. When generated with the PEP extension, ACF/NCP/VS can emulate the operation of an IBM 2701 Data Adapter Unit or an IBM 2702 or 2703 Transmission Control, or any combination of these units. When defining ACF/NCP/VS, the system programmer specifies that the program include the PEP extension and specifies each communication line controlled by ACF/NCP/VS as being operable in network control mode only, in emulation mode only, or alternately in either mode. A line specified as operable in either mode is changed from one mode to the other upon command from the network operator via the access method (ACF/TCAM only). ACF/NCP/VS with the partitioned emulation programming extension allows user programs and access methods written for support of the IBM 2701, 2702, and 2703 to coexist in a network with programs designed to communicate with SNA and non-SNA stations via ACF/NCP/VS.

ACF/TCAM can communicate with BSC and start-stop stations on lines operating in emulation mode as well as with SNA, BSC, and start-stop stations on lines operating in network control mode.

ACF/VTAM communicates with stations on lines in network control mode only. Both ACF/TCAM and ACF/VTAM can coexist in the same multiple-domain network or in multiple single-domain networks that share an ACF/NCP/VS.

For further information on the partitioned emulation programming extension. (See *ACF/NCP/VS General Information*, GC30-3058.)

## ***Coexistence of Single-Domain Networks***

A single network configuration may include the non-ACF access methods—TCAM and VTAM—as well as ACF/TCAM and/or ACF/VTAM, and the non-ACF network control program—NCP/VS—as well as ACF/NCP/VS. A single copy of each access method (VTAM and TCAM) can coexist in the same host processor and communicate with separate network control programs (ACF/NCP/VS or NCP/VS) or with the same ACF/NCP/VS. However, a single host processor cannot execute two VTAMs (ACF or non-ACF) or two TCAMs (ACF or non-ACF).

Where the network configuration has no cross-domain connections but does include multiple access methods, each access method owns and manages its own resources as a single-domain network.

The network configuration may also include access methods other than ACF/TCAM, ACF/VTAM, TCAM, and VTAM. For example, the configuration could also include BTAM (Basic Telecommunications Access Method). As is the case for the access methods stated above, BTAM could own and manage its own resources as a single domain, though the term *domain* is normally applied only to ACF/VTAM and ACF/TCAM.

When the same host processor executes two access methods, each may communicate with a separate application program (or a separate group of application programs). Or, both access methods may communicate with the same application program, provided that the application program has the required macro instructions to communicate with each access method.

## ***Migration with Single-Domain Networks***

The term *migration* is applied to the process of replacing a given level of a program with a later level of the same program or with a program having equivalent functions. The usual goal of migration is to gain some benefit, such as new or improved functions, that the later level offers as compared with the replaced level. The migration process includes any required conversions or modifications to other program components with which the replaced component communicates. The program modifications or conversions may be required to enable the new level to continue to perform the functions that the replaced level performed, as well as to perform the new functions that the later level makes possible. The number of conversions or modifications required, and the difficulty of making them, determines the relative complexity of the migration process.

The various levels of ACF access methods and network control programs are designed to simplify the migration process by permitting the various programming components in a network to be individually replaced without requiring immediate replacement of related components. For example, NCP/VS may be replaced by ACF/NCP/VS, or one release of ACF/NCP/VS may be replaced by a later release, without requiring the simultaneous replacement of the access method(s) by a later level. In general, the existing functions will continue to operate unchanged. Most new ACF/NCP/VS functions, however, will operate only after the access method has been upgraded to the level designed to support those functions.

Similarly, a non-ACF access method (TCAM or VTAM) may be replaced by the ACF equivalent, or one level of ACF/TCAM or ACF/VTAM may be replaced by a later level without requiring the simultaneous replacement of the network control program by a later level. Again, the existing functions will generally continue to operate unchanged. Some new access method functions, however, will operate only after the network control program has been upgraded to the level designed to support those functions.

Figure 2-5 illustrates, in general, how a network can be upgraded through successive conversion of single program components to later levels in step-by-step fashion. As shown, the sequence in which components are upgraded is (1) access method, (2) NCP, (3) NCP, (4) access method. Any other sequence is valid—for example, (1) NCP, (2) access method, (3) NCP, (4) access method—so long as the upgraded access method continues to support the back-level NCP functions required by the installation, or vice versa. No recompiling or recoding of ACF/TCAM application programs is necessary at any step. ACF/VTAM application programs may have to be recompiled or recoded if they rely on functions that the upgraded network will discontinue or if they wish to take advantage of new functions.

### ***Summary of ACF/VTAM Capabilities***

Described below are the capabilities that ACF/VTAM Release 2 provides for single-domain networks, in addition to or different from those available in non-ACF VTAM. These capabilities apply in general to multiple-domain networks as well. For a description of the non-ACF VTAM capabilities, see *Introduction to VTAM*, GC27-6987.

This summary makes no distinction between those capabilities provided only by Release 2 of ACF/VTAM and those provided by both Release 1 and Release 2 of ACF/VTAM. Some functions summarized below depend on communication with access methods elsewhere in the network and require that those access methods be at a minimum release level. These and other dependencies attendant to use of some functions are beyond the scope of this publication to describe in detail.

***Application Program-to-Application Program Sessions:*** ACF/VTAM supports single or multiple sessions between two ACF/VTAM application programs in the same host processors or (for multiple-domain networks) in separate host processors. Data transfer in these sessions is in record mode. One of the application programs must serve in a primary role for session establishment and control; the other application program must assume a secondary role. This capability allows an application program to provide centralized services for processing and control to other application programs as well as to stations.

***Status Display Facilities:*** The network operator display facilities provide additional information on the status of local stations, communication lines, remote stations, logical units, physical units, application programs, and buffer-pool utilization.

***Dynamic Buffering:*** ACF/VTAM supports the dynamic allocation of ACF/VTAM buffer pools. When a buffer pool reaches a user-defined threshold, additional buffers are allocated.

***Statistics Collection and Recording:*** This facility collects statistics on input/output operations and buffer utilization to provide information that can be used to adjust certain ACF/VTAM and ACF/NCP/VS system definition and initialization parameters. Collected statistics can be displayed or printed offline.

***Bidirectional Pacing:*** ACF/VTAM supports pacing of data flow, in both directions, in LU-LU sessions between stations and application programs and between pairs of application programs. Pacing the data flow to an application program is useful in preventing the buffer allocation from being exceeded when large amounts of data are being transferred to the program.

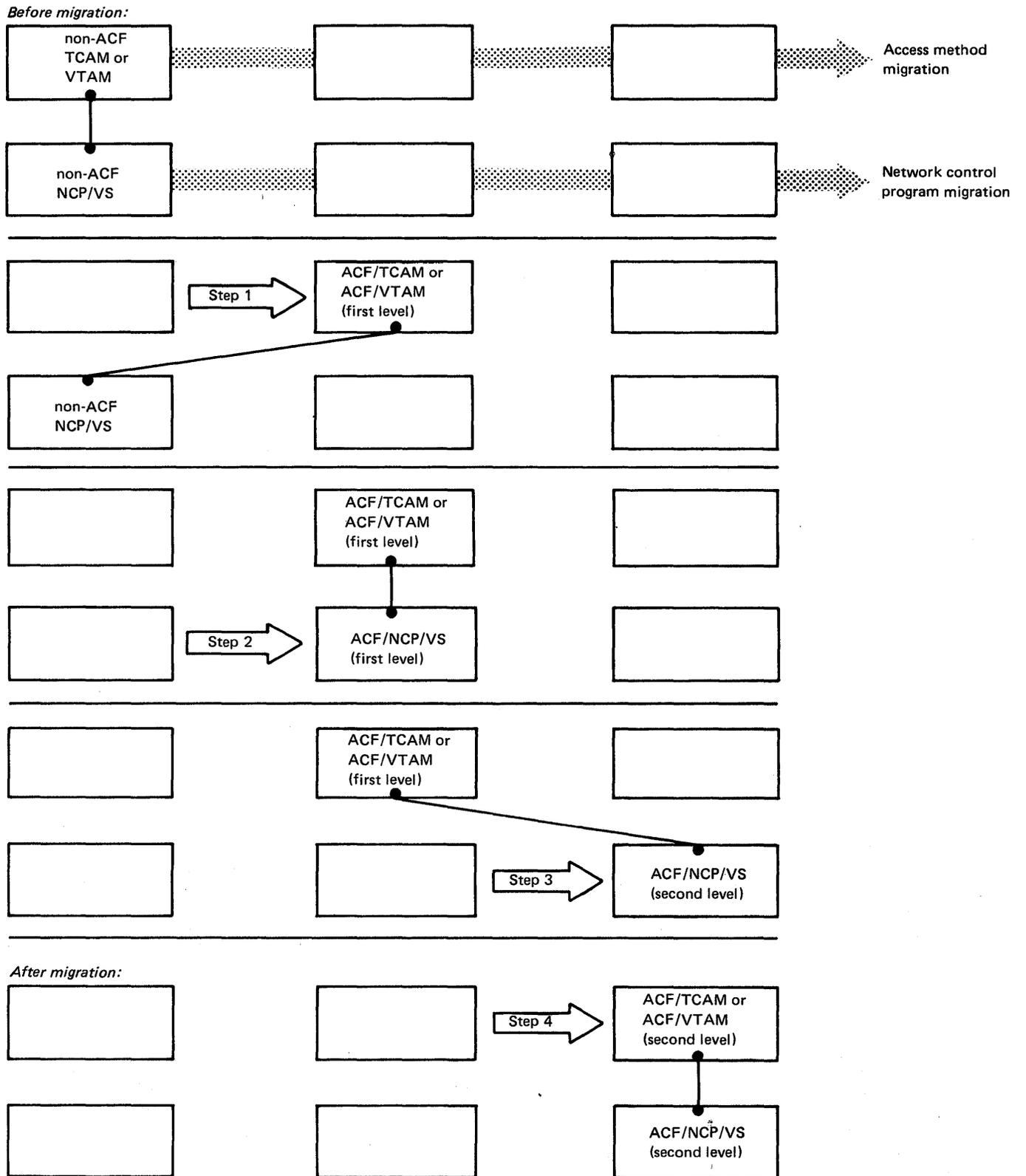


Figure 2-5. Step-by-Step Access Method/Network Control Program Migration

*Improved Switched Network Backup:* ACF/VTAM provides improved switched network backup support for SNA stations. This support allows: (1) stations associated with a failed or deactivated nonswitched link to be reactivated through an alternate switched connection; and (2) logical units associated with a failed or deactivated physical unit (either switched or nonswitched) to continue to participate in sessions through reconfiguration to a backup switched physical unit.

*Shared ACF/NCP/VS:* ACF/VTAM supports the multiple-attachment capability of the 3705 communications controller, which permits the attachment of a single local communications controller to as many as four host processors, thus forming up to four separate, independent networks.

*Serviceability:* ACF/VTAM's trace capabilities support buffer and input/output traces for application-program sessions with SNA stations and other application programs. ACF/VTAM also supports the ACF/NCP/VS capability for tracing up to eight communication lines concurrently and for testing of the principal SDLC link between communications controllers.

*Dynamic Reconfiguration:* By entering commands at a network console, a network operator can dynamically reconfigure the network to logically add or delete SNA stations on nonswitched SDLC links controlled by ACF/NCP/VS. The network control program need not be modified, regenerated, and reloaded into the communications controller. However, dummy logical units must have been predefined in the network control program in order to add LUs to the network. Dynamic reconfiguration is only a temporary measure to avoid disrupting network operation to modify, regenerate, and reload the network control program. At a convenient time, as when network operation is suspended at the end of day, the network control program should be updated to reflect any new stations that have been permanently added to the network.

*Encrypt/Decrypt Feature:* ACF/VTAM (under OS/VS only) can be equipped with the separately orderable Encrypt/Decrypt feature for users whose application requirements include the need for assuring the security of data as it passes through the network. This feature, when used with the Programmed Cryptographic Facility program product, allows users to establish, control, and terminate access to stations and application programs with cryptographic sessions. In these sessions, data requiring high security is enciphered when entering the network and deciphered when leaving the network. Information on the Encrypt/Decrypt feature may be found in *ACF/VTAM General Information: Concepts*, GC27-0463. Information on the Programmed Cryptographic Facility program product can be found in *Programmed Cryptographic Facility General Information*, GC28-0942.

*Negotiable Session Initialization Parameters:* The initialization of sessions between user-written application programs is made more flexible through the ability for the user to specify some session bind parameters during program execution rather than requiring that they be defined during program generation. During initialization, the two application programs participating in a session can dynamically exchange certain session parameters to establish and/or modify the SNA protocols to be used during the session.

*Enhanced SDLC Data Link Testing:* Individual stations on a SDLC link can be tested without interfering with sessions involving other stations on the link. When a station comprises a cluster control unit and its attached devices, the control unit is dedicated to the test and its attached devices must be deactivated.

*Terminal Connectivity Testing:* A terminal operator can initiate an echo test from an SNA or non-SNA terminal to determine that the entire path to the access method (ACF/VTAM) is operational. The test does not interfere with any other stations on the link involved in the test and does not interfere with other terminals on the control unit involved in the test.

*Dynamic Display of ACF/NCP/VS Storage:* A network operator can display any contiguous areas of ACF/NCP/VS storage, from 32 bytes to 256 bytes in length, without disrupting normal ACF/NCP/VS operation. The specified storage area is displayed in hexadecimal form on a network operator console. This dynamic display of ACF/NCP/VS storage can be useful in evaluating the status of the network and in determining problems.

*Dynamic Dump of ACF/NCP/VS Storage:* A network operator can obtain a dump of ACF/NCP/VS storage from a channel-attached or SDLC link-attached 3705 communications controller. Because the ACF/NCP/VS continues to operate during the dump process, the dump represents the status of ACF/NCP/VS over a period of time. The dump contents are recorded and printed via the facilities of the system support programs for ACF/NCP/VS. Analyzing the contents of the dump can be useful in evaluating problems in the network.

*Intensive Mode Error Recording:* A network operator can dynamically invoke and terminate recording of information about temporary errors occurring on an SDLC link. This capability permits a user to collect additional information on link errors beyond what is collected for permanent errors. This detailed information may preclude the need for more specific testing of a link to recreate an error situation.

*Enhanced Network Operator Control for Session Termination:* By using the VARY operator command, a network operator can terminate LU-LU sessions between an application program in an ACF/VTAM domain and either a station or another application program in an ACF/VTAM or an ACF/TCAM domain. Operator-initiated termination of a session does not interfere with any other sessions in which the application program may be engaged and does not terminate execution of the application program.

Similarly, the network operator can terminate LU-LU sessions between a station in an ACF/VTAM domain and an application program in an ACF/VTAM or ACF/TCAM domain.

*Support of Related Communications Control and Problem Determination Program Products:* ACF/VTAM provides an interface to support the Network Communications Control Facility (NCCF) program product and its related Network Problem Determination Application (NPDA) program product, as well as the Network Operation Support Program (NOSP) program product. The General Information publications for these products are listed in the Preface.

*Support of Non-SNA Stations Via Network Terminal Option:* The following non-SNA stations are supported by the record application program interface of ACF/VTAM via the Network Terminal Option program product in conjunction with ACF/NCP/VS.

- IBM 2740 Model 1 Communication Terminal (nonswitched and switched lines)
- IBM 2741 Communication Terminal (nonswitched and switched lines)
- Western Union Teletypewriter Exchange Service (TWX) Model 33/35 terminals (switched lines only)
- World Trade Teletypewriter Terminals (nonswitched lines only)

Information on the Network Terminal Option may be found in *Network Terminal Option General Information*, GC38-0297.

TSO/VTAM supports the IBM 2741, Western Union TWX (Model 33/35), and World Trade teletypewriter terminals via the Network Terminal Option program product.

### ***Summary of ACF/TCAM Capabilities***

Described below are the capabilities that ACF/TCAM Version 2 (Release 1 and 2) provides for single-domain networks in addition to or different from those available in non-ACF TCAM. These capabilities apply in general to multiple-domain networks as well. For a description of the non-ACF TCAM capabilities, see *OS/VS TCAM Concepts and Applications*, GC30-2049.

This summary makes no distinction between those capabilities provided only by Version 2 of ACF/TCAM and those provided by both Version 1 and Version 2 of ACF/TCAM.

*Remote Communications Controller:* ACF/TCAM supports SDLC, BSC, and start-stop stations connected to a remote 3705 communications controller by communication lines operating in network control mode.

*Switched Line Support for Remote SNA Stations:* ACF/TCAM supports remote SNA stations connected to switched links. ACF/TCAM handles identification checking, telephone numbers, and call scheduling. Operator control allows both the station to be called and the link over which the call must be made to be specified to the network operator.

*Display Facilities:* ACF/TCAM can display the identification of a communication line, given a station name; the station name, given the identification of a line; and the status of the line. In addition, the display facilities can indicate separately those lines currently in use for communicating with a station and those that are not currently in use and are available for calls.

*Bidirectional Pacing:* ACF/TCAM supports pacing of data flow, in both directions, in LU-LU sessions between stations and application programs and between pairs of application programs. Pacing the data flow to an application program is useful in preventing the buffer allocation from being exceeded when large amounts of data are being transferred to the program.

*Improved Switched Network Backup:* ACF/TCAM provides improved switched network backup support for SNA stations. This support allows (1) stations associated with a failed or deactivated nonswitched link to be reactivated through an alternate switched connection; and (2) logical units associated with a failed or deactivated physical unit (either switched or nonswitched) to continue to participate in sessions through reconfiguration to a backup switched physical unit.

*Shared ACF/NCP/VS:* ACF/TCAM supports the multiple-attachment capability of the 3705 communications controller, which permits the attachment of a single local communications controller to as many as four host processors, thus forming up to four separate, independent networks.

*Serviceability:* ACF/TCAM's trace capabilities support the ACF/NCP/VS capability for tracing up to eight communication lines concurrently and for testing of the principal SDLC link between communications controllers.

*Statistics Collection and Recording:* This facility collects statistics on peak and current usage of resource pools. Also, ACF/TCAM keeps track of traffic and error counts for stations connected to communications controllers. The collected statistics can be displayed.

*Pageable Control Blocks:* ACF/TCAM permits a choice of either fixed or pageable storage for certain tables and control blocks for remote stations. This capability allows ACF/TCAM users considerable flexibility in balancing storage requirements against throughput and response time.

*Dynamic Reconfiguration:* By entering commands at a network console, a network operator can dynamically reconfigure the network to add or delete SNA stations on non-switched SDLC links controlled by ACF/NCP/VS. The network control program need not be modified, regenerated, and reloaded into the communications controller. However, a pool of dummy logical units must have been predefined in the network control program in order to add LUs to the network. ACF/TCAM checkpoints the changes effected by dynamic reconfiguration and “remembers” them so that subsequent restarting of ACF/TCAM does not require that the network operator re-enter the dynamic reconfiguration commands.

Dynamic reconfiguration is only a temporary measure to avoid disrupting network operation to modify the network control program. At a convenient time, as when network operation is suspended at the end of the day, the network control program should be updated to reflect any new stations added by dynamic reconfiguration that are to remain in the network permanently.

*Support of Programmed Cryptographic Facility:* ACF/TCAM supports the Programmed Cryptographic Facility program product, which is of value to users whose application requirements include the need for assuring the security of data flowing through the network. ACF/TCAM's support, in combination with the Programmed Cryptographic Facility, allows users to establish, control, and terminate access to stations and application programs with cryptographic sessions in which data requiring high security is enciphered when entering the network and deciphered when leaving the network. Information on the Programmed Cryptographic Facility may be found in *Programmed Cryptographic Facility General Information*, GC28-0942. Information on the ACF/TCAM support for this facility may be found in *ACF/TCAM General Information: Functional Description*, GC30-3131.

*Negotiable Session Initialization Parameters:* The initialization of sessions between user-written application programs or message handlers is made more flexible through the ability for the user to specify some session bind parameters during program execution rather than requiring that they be defined during program generation. During initialization, the two application programs or message handlers participating in a session can dynamically exchange certain session parameters to establish and/or modify the SNA protocols to be used during the session.

*Enhanced SDLC Data Link Testing:* Individual stations on a SDLC link can be tested without interfering with sessions involving other stations on the link. When a station comprises a cluster control unit and its attached devices, the control unit is dedicated to the test and its attached devices must be deactivated.

*Terminal Connectivity Testing:* A terminal operator can initiate an echo test from an SNA or non-SNA terminal to determine that the entire path to the access method (ACF/TCAM) is operational. The test does not interfere with any other stations on the link and does not interfere with other terminals on the control unit involved in the test.

*Dynamic Display of ACF/NCP/VS Storage:* A network operator can display any contiguous 256 bytes of ACF/NCP/VS storage without disrupting normal ACF/NCP/VS operation. The specified storage area is displayed in hexadecimal form on a network operator console. This dynamic display of ACF/NCP/VS storage can be useful in evaluating the status of the network and in determining problems.

*Intensive Mode Error Recording:* A network operator can dynamically invoke and terminate recording of information about temporary errors occurring on an SDLC link. This capability permits a user to collect additional information on link errors beyond what is collected for permanent errors. This detailed information may preclude the need for more specific testing of a link to recreate an error situation.

*Support of Related Communications Control and Problem Determination Program*

*Products:* ACF/TCAM provides an interface to support the Network Communications Control Facility (NCCF) program product and its related Network Problem Determination Application (NPDA) program product. The General Information publications for these products are listed in the Preface.

*Support of Application Subsystems:* ACF/TCAM allows many application subsystems and service programs (such as CICS/VS, IMS/VS, JES2, JES3, and VSPC) to be executed in the same host processor as, and to share stations in the network with, ACF/TCAM application programs. ACF/TCAM also supports single SNA sessions between IBM application subsystems that support interhost communication. For specific information on the subsystems that ACF/TCAM supports, see *ACF/TCAM General Information: Introduction*, GC30-3057.

*Enhanced Installability and Usability Options:* ACF/TCAM provides several facilities that can aid the user in installing and using this access method. Among these facilities are the following: (1) *an initiator program* that functions as a master task for the ACF/TCAM message control program, providing for automatic activation, monitoring, and selective restarting of the message control program and associated IBM-supplied or user-supplied service programs; (2) *enhanced message handler facilities* that improve the usability and flexibility of ACF/TCAM session establishment, routing control, security checking, logon and logoff message handling, and error handling; (3) *enhanced operator control facilities* that provide commands for transferring, copying, and purging queues of unsent messages; commands useful in managing large networks; an online operator's guide that displays available commands and details of command formats; and the means for adding user-written commands; and (4) *a set of model message control programs* that the user can execute as supplied or modify as needed. These installability and usability options are described in *ACF/TCAM General Information: Introduction*, GC30-3057.

## ***Summary of ACF/NCP/VS Capabilities***

Described below are the capabilities that ACF/NCP/VS, Release 1 and 2, provide for single-domain networks in addition to those available in non-ACF NCP/VS. These capabilities apply in general to multiple-domain networks as well. For a description of the non-ACF NCP/VS capabilities, see *Introduction to the IBM 3704 and 3705 Communications Controllers*, GA27-3051.

This summary makes no distinction between those capabilities provided only by Release 2 of ACF/NCP/VS and those provided by both Release 1 and Release 2 of ACF/NCP/VS. Some functions summarized below depend on communication with network control programs elsewhere in the network and require that those programs be at a minimum release level. These and other dependencies attendant to use of some functions are beyond the scope of this publication to describe in detail.

*Duplex Operation over Wideband Links:* ACF/NCP/VS allows duplex operation on SDLC links at speeds up to 57 600 bits per second.

*Remote Attachment of 3705-II Communications Controller:* The 3705-II communications controller can be remotely attached to a local 3705 communications controller by an SDLC link. ACF/NCP/VS in the local controller can communicate with a network control program in the remote controller at line speeds up to 57 600 bits per second.

*Local-Local Links between Communications Controllers:* ACF/NCP/VS can control an SDLC link between two local communications controllers in the same domain or in adjacent domains.

*Multiple Channel Attachment Capability:* ACF/NCP/VS supports the concurrent attachment of a single 3705-I communications controller to two data channels (on the same or separate host processors) and a single 3705-II communications controller to two, three, or four channels (on the same or separate host processors). This capability allows (but does not require) a single 3705 and its attached network resources to be partitioned into separate, independent networks. The 3705 and the SDLC links can thus be shared by multiple host processors or multiple access methods in the same host processor. Resources of the network can be moved from one domain to another under operator control.

*Serviceability:* ACF/NCP/VS can perform line traces on up to eight communication lines concurrently. Also, either a local-local or a local-remote link, or a backup link for a local-local or local-remote link, can be tested by an echo test while normal data traffic is flowing on the link not being tested. In addition, ACF/NCP/VS permits channel traces to be turned on and off dynamically from the control panel of the 3705 and also permits the contents of 1 byte of storage to be altered dynamically from the control panel.

*Dynamic Reconfiguration:* By entering commands at a network console, a network operator can dynamically reconfigure the network to add or delete SNA stations on non-switched SDLC links controlled by ACF/NCP/VS. The network control program need not be modified, regenerated, and reloaded into the communications controller. However, a pool of dummy logical units must have been predefined in the network control program in order to add LUs to the network. Dynamic reconfiguration is only a temporary measure to avoid disrupting network operation to modify the network control program. At a convenient time, as when network operation is suspended at the end of the day, the network control program should be updated to reflect any new stations and logical units added by dynamic reconfiguration that are to remain in the network permanently.

*Enhanced SDLC Data Link Testing:* Individual stations on an SDLC link can be tested without interfering with sessions involving other stations on the link. When a station comprises a cluster control unit and its attached devices, the control unit is dedicated to the test and its attached devices must be deactivated.

*Intensive Mode Error Recording:* A network operator can dynamically invoke and terminate recording of information about temporary errors occurring on an SDLC link. This capability permits a user to collect additional information on link errors beyond what is collected for permanent errors. This detailed information may preclude the need for more specific testing of a link to recreate an error situation.

*Dynamic Display of ACF/NCP/VS Storage:* A network operator can display any contiguous 256 bytes of ACF/NCP/VS storage without disrupting normal ACF/NCP/VS operation. The specified storage area is displayed in hexadecimal form on a network operator console. This dynamic display of ACF/NCP/VS storage can be useful in evaluating the status of the network and in determining problems.

*Support for Network Communications Control Facility:* ACF/NCP/VS supports the enhanced problem determination and network operation facilities offered by the Network Communications Control Facility (NCCF) program product and a related program product, Network Problem Determination Application (NPDA). Information on these program products may be found in the related General Information publications, listed in the Preface.

*Support for Network Terminal Option:* ACF/NCP/VS supports the Network Terminal Option program product by allowing inclusion in the ACF/NCP/VS of IBM-provided code that extends record mode operations to IBM 2741, IBM 2740 Model 1, Western Union TWX (Model 33/35), and World Trade Teletypewriter terminals. The support allows these stations to participate in multiple-domain as well as single-domain network operations.

*Inclusion of User Routines and Network Addressable Units:* ACF/NCP/VS allows user-written routines to be included in an ACF/NCP/VS for execution during initialization of the ACF/NCP/VS. ACF/NCP/VS also allows user-written network addressable units (NAUs) to be included and executed during ACF/NCP/VS operation. These routines may be used to add programmed SNA resources, to support non-SNA devices through user-written code, and/or to add line control protocols not provided by IBM in ACF/NCP/VS but compatible with the Type 2 or Type 3 communication scanners of the 3705 communications controller. (Possible future releases of ACF/NCP/VS may require changes to the user-written code.)

## Chapter 3. ACF Level 2 Facilities for a Multiple-Domain Network

Chapter 2 described the capabilities that Advanced Communications Function makes available for SNA-based, single-domain networks. The single-domain facilities accommodate multiple concurrent application programs and both SNA and non-SNA stations. The single-domain facilities also permit extensive sharing of network resources (stations, links, and application programs) within a domain. While multiple single-domain networks may coexist, perhaps with two SSCPs occupying the same host processor and sharing the same ACF/NCP/VS, the networks remain independent of one another. No communication between domains is possible and resources cannot be shared among domains. Figure 3-1 shows four independent networks, two of which share a single network control program.

This chapter describes the capabilities provided by the Multisystem Networking Facility of ACF/TCAM Version 2 Release 2 and ACF/VTAM Release 2 in conjunction with ACF/NCP/VS Release 2. These facilities allow two or more independent networks to be consolidated into a single coordinated network called a multiple-domain network. This consolidation of domains is called *networking*. Figure 3-2 shows the four networks of Figure 3-1 consolidated into a single, multiple-domain network. The links between network control programs that join the formerly separate networks are called *cross-domain links*.

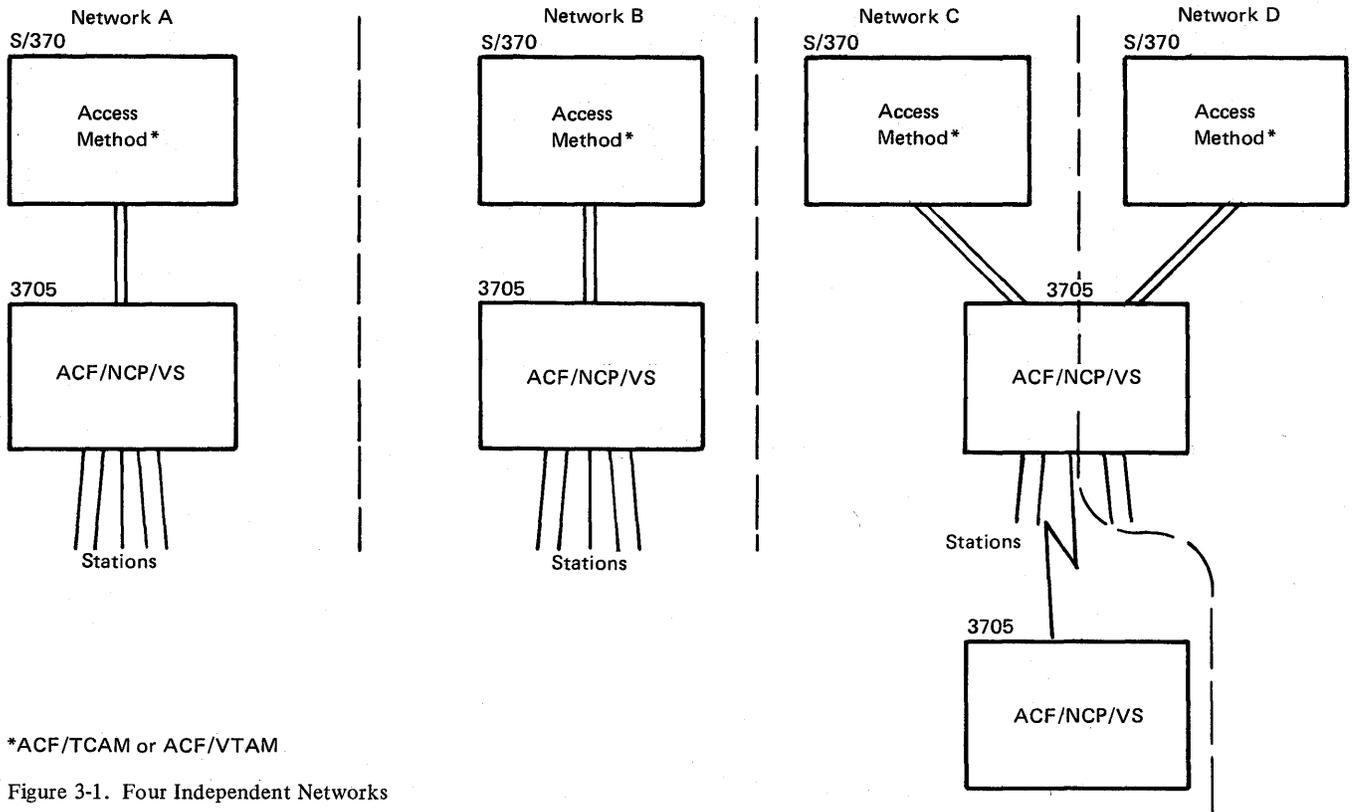
Some advantages of networking are as follows.

- Stations and logical units can gain access to application programs regardless of the domain in which the programs reside, as shown in Figure 3-3 (a).
- Application programs can gain access to stations and logical units and to other application programs regardless of the domain in which these resources reside, as shown in Figure 3-3 (b).
- As a consequence of the increased access by stations, logical units, and application programs just mentioned, redundant application programs can be eliminated. That is, the network can be arranged so that a single copy of a given application program can serve users in any domain.
- Application programs can be made insensitive to the locations of stations and logical units involved in cross-domain communication.
- Cross-domain communication can continue following some kinds of failures in the network.
- Communication line charges can possibly be decreased through use of cross-domain resources.
- Improved backup capability can be provided for critical applications or stations.

Level 3 of ACF, described in Chapter 4, provides other advantages of networking.

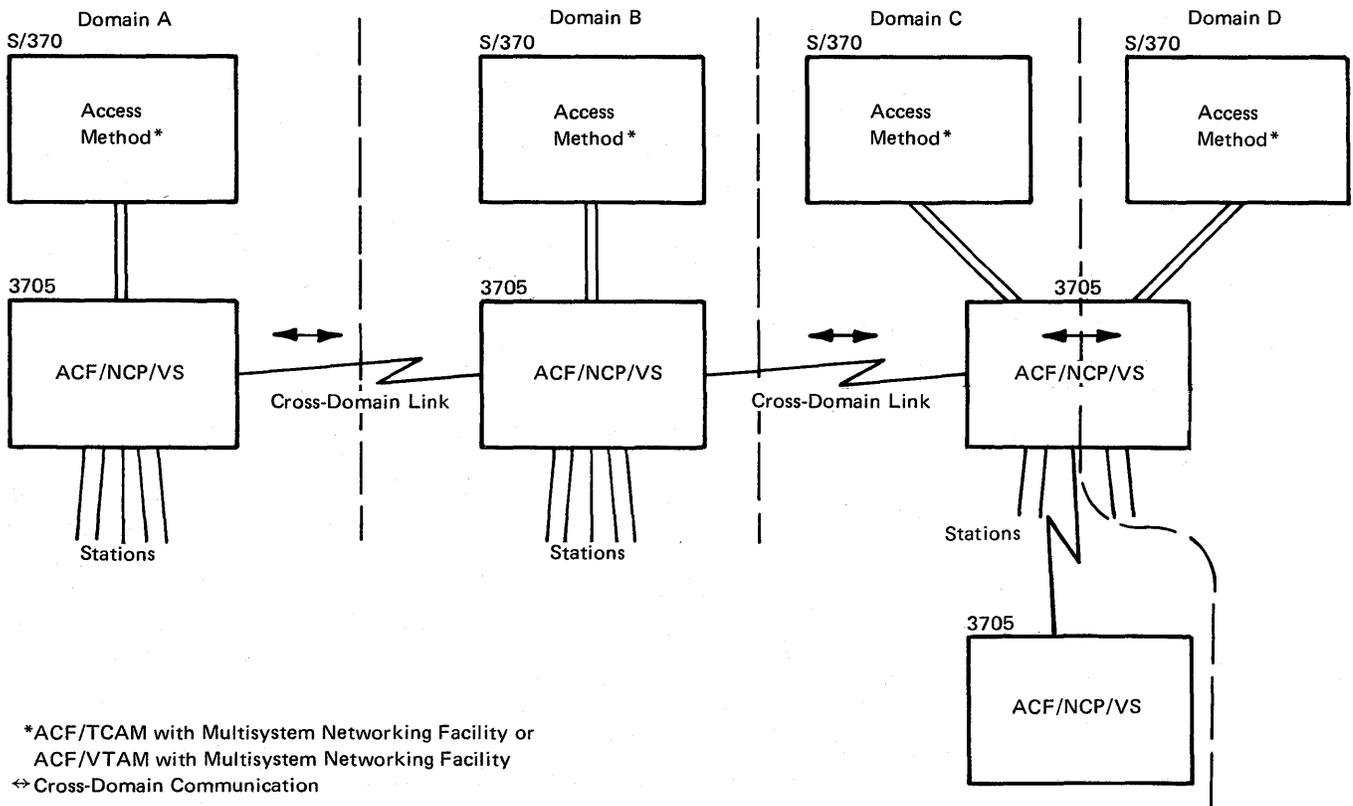
*Networking* is the term representing the ability of an ACF/VTAM or ACF/TCAM application program in one domain to communicate with either another application program or a station in some other domain without involving host processing in intervening domains. This concept, although not restricted to use with SNA stations, is most easily understood in terms of the SNA concept of LU-LU sessions. Thus, unless a distinction is required between SNA and non-SNA stations, the networking concepts are explained in terms of SNA logical units.

Structural differences between ACF/VTAM and ACF/TCAM necessitate an understanding of the terminology used when referring to the ACF/VTAM and ACF/TCAM access methods. In most instances ACF/VTAM and ACF/TCAM can be referred to interchangeably. A distinction is made when required; if none is needed, the term *access*



\*ACF/TCAM or ACF/VTAM

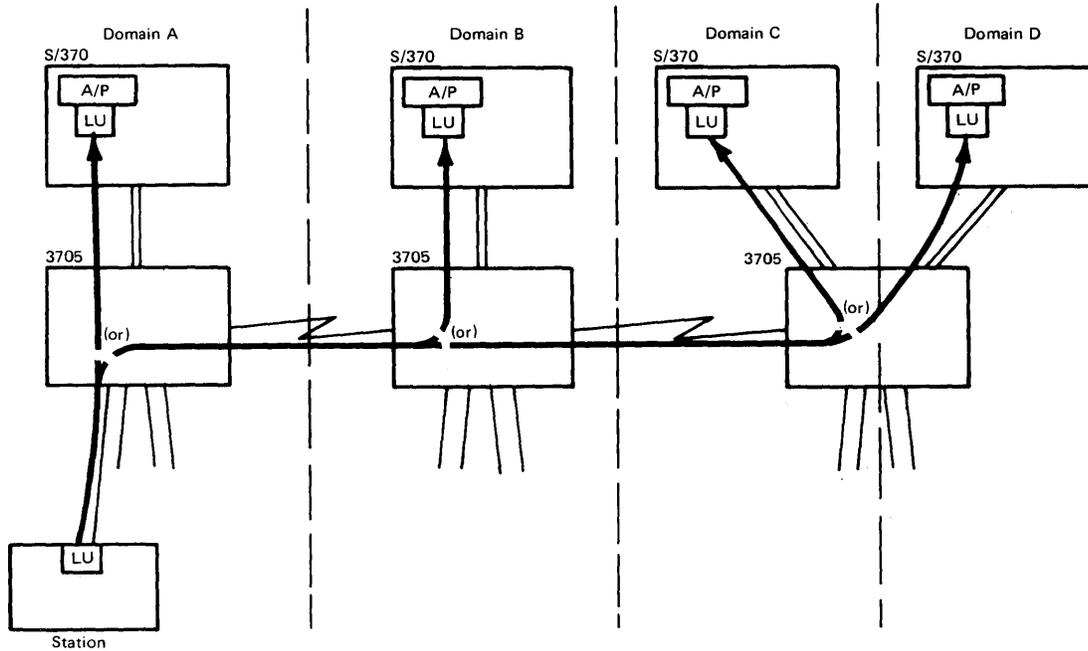
Figure 3-1. Four Independent Networks



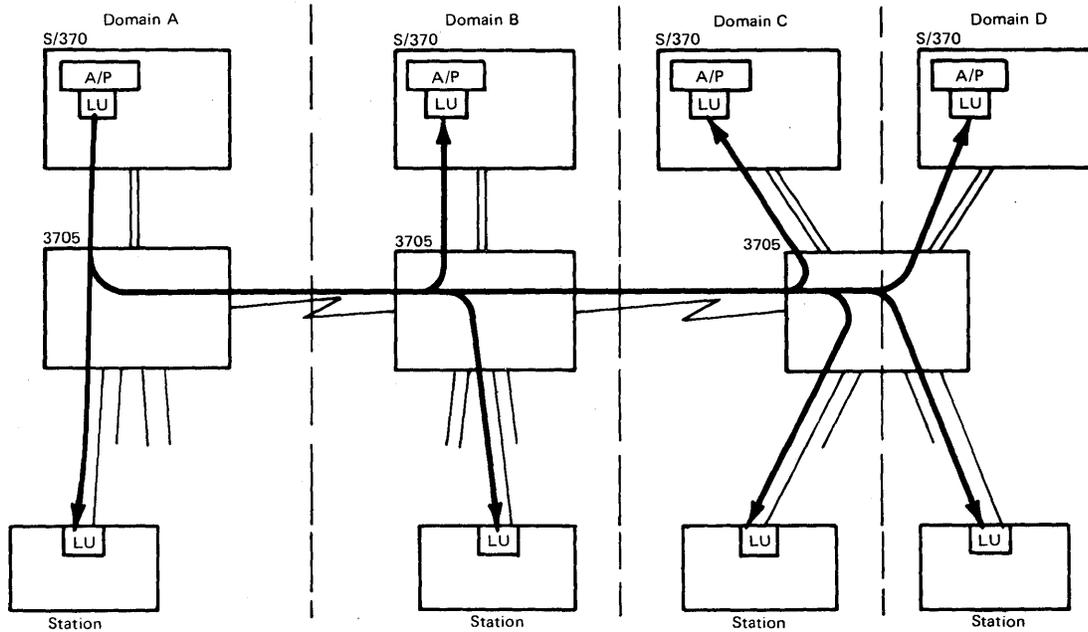
\*ACF/TCAM with Multisystem Networking Facility or  
ACF/VTAM with Multisystem Networking Facility

↔ Cross-Domain Communication

Figure 3-2. Four Networks Consolidated into a Single, Four-Domain Network



(a) A LU in a Station can Access an Application Program in the Same Domain or Another Domain



(b) An Application Program Can Access Stations or Application Programs in Other Domains

A/P - Application Program  
 LU - Logical Unit

Figure 3-3. Cross-Domain Access by Stations and Application Programs

*method* is used to represent either ACF/TCAM or ACF/VTAM. ACF/VTAM application programs provide some of the logical unit functions and all of the end user functions of an SNA network while ACF/TCAM application programs are actually the end users and ACF/TCAM itself contains the logical unit associated with the ACF/TCAM application program. For simplicity the term *host LU* is used to mean either the ACF/VTAM application program or the part of ACF/TCAM that initiates and maintains a session on behalf of ACF/TCAM.

In networking, one end of an LU-LU session is always a host LU. Once an LU-LU session is established, data may flow in either direction using the networking facilities of the access method and ACF/NCP/VS. LU-LU session protocols require that one end of the session be a primary LU and the other end be a secondary LU. In sessions between a host LU and a station (or logical unit), the host LU is always the primary LU.

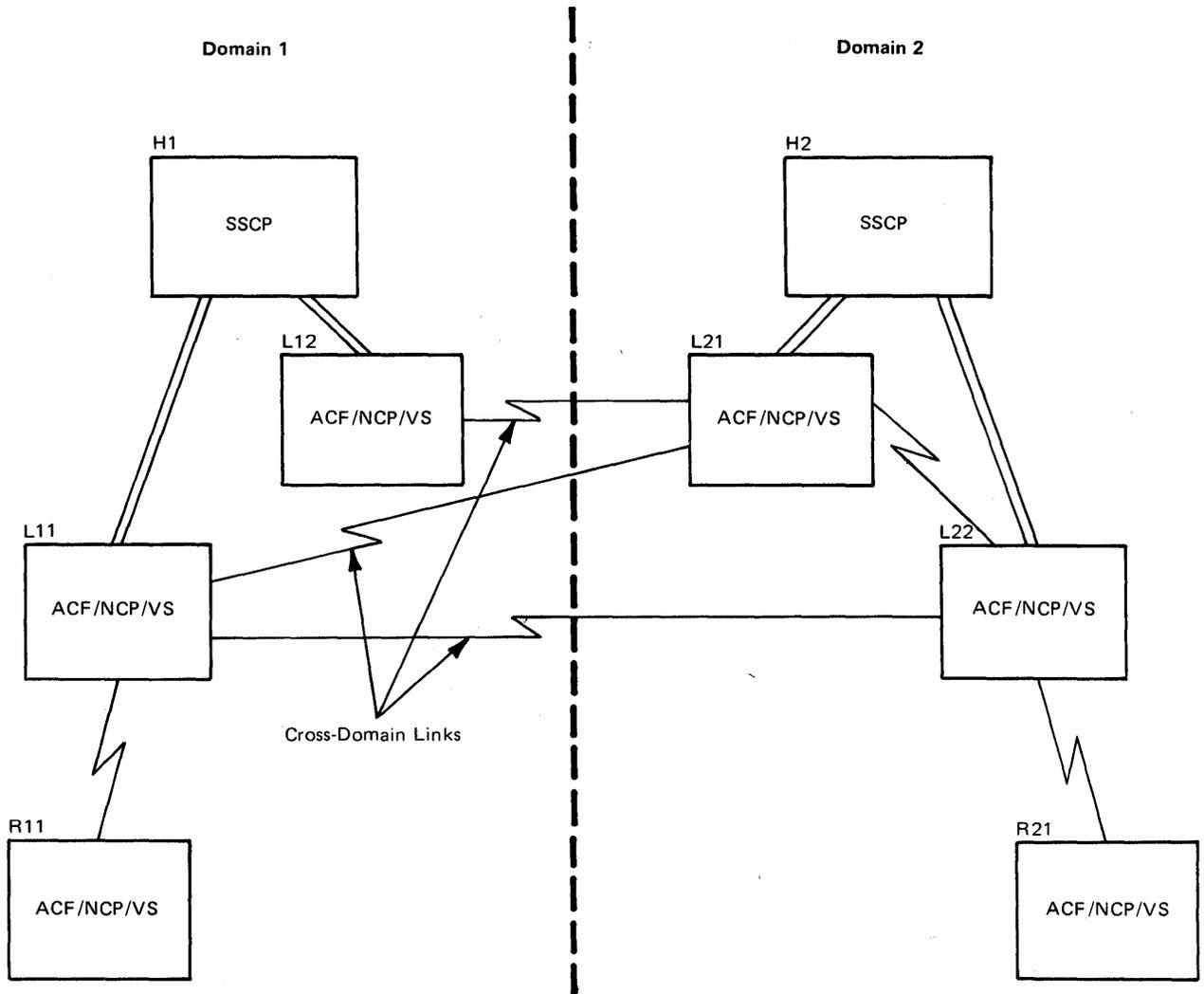
### Cross-Domain Data Links

In networks controlled by Level 2 of ACF, cross-domain data links connect only local communications controllers (attached to the host processor by a data channel). No cross-domain data links between remote communications controllers, or between a local and a remote communications controller, are possible. The data links are normally nonswitched but can be manually dialed (switched). All cross-domain links use the SDLC discipline. Both domains joined by the link participate equally in the activation of the link.

Multiple cross-domain links are possible if multiple communications controllers are available. This capability is shown in Figure 3-4. This example shows three cross-domain links between domain 1 and domain 2. A possibility for a fourth link exists between L12 and L22 but is not shown. (In this and succeeding figures, H represents a host processor, L represents a local communications controller, and R represents a remote communications controller. LU represents a logical unit, C represents a cluster controller, and S represents a station.)

In networks controlled by Level 2 of ACF, multiple links between domains do not provide alternate routing or multiple routes. However, multiple links do allow selection of routing based on anticipated network traffic or other pertinent business considerations. A selected route must be the same in both directions. (See the section on "Network Addressing and Routing.")

Expanded networking capabilities are offered by Level 3 of ACF, as described in Chapter 4.



*Note:* SSCP may be in either ACF/TCAM or ACF/VTAM.

Figure 3-4. Multiple Cross-Domain Links

### Cross-Domain Resources

The resources that can be shared directly across domains in the networking environment depend on the access methods involved in both ends of a cross-domain session.

If one or both ends of a session are in an ACF/VTAM-controlled domain or an ACF/TCAM-controlled domain, host LUs, remote SNA stations (LUs), remote BSC 3270 stations, and local (channel-attached) SNA 3270 and 3790 stations can be shared across domains. Local (channel-attached) SNA and non-SNA 3270 stations also can be shared across domains, as can (for ACF/VTAM) remote non-SNA stations supported by the Network Terminal Option. (Of the local 3270 stations, ACF/TCAM supports only the 3274.)

If both ends of the session are in ACF/TCAM-controlled domains, remote BSC and start-stop stations also can be shared across domains.

For either ACF/TCAM or ACF/VTAM, the ability to communicate with cross-domain resources is not influenced by access methods in intervening domains.

### **Initiating Cross-Domain SNA Sessions**

LU-LU sessions can be initiated only after the SSCP has established SSCP-PU and SSCP-LU sessions. In a cross-domain network, each domain contains an SSCP. Sessions are first established in each domain between its SSCP and the respective PUs and LUs in that domain. Requests for a cross-domain LU-LU session require that the access methods initially establish a session between the SSCPs in each domain. As shown in Figure 3-5, the requests for a session between LU 11 and a host LU in host processor H3 must pass through the host processor in both domains 1 and 3. After the LU-LU session is initiated, the data flow is directly between the LUs. Neither the session initiation/termination flow nor the data flow must pass through host processors in intervening domains.<sup>1</sup> The flows pass through only those network elements that are specified as the path between the end points.

### **Naming Resources**

A key characteristic of the access methods for session establishment is that all references to network resources are by symbolic name. In single-domain networks, this characteristic frees the application program and network operator from concern about the location of the resources within the network. All address translation from the symbolic name to the actual network address is performed by the access method. Thus, the symbolic names used in each domain must be unique within each domain. The symbolic names of resources to be used across domains must be unique across all domains that may use these resources concurrently. The essential characteristic of a unique name is that it cannot concurrently define multiple resources to an access method. For example, the same name cannot be used concurrently to represent both a single-domain and a cross-domain resource.

### ***Network Addressing and Routing***

Subarea addressing is used to establish the path of data flow throughout the network. A unique subarea address is assigned to each host processor and each communications controller, as shown in Figure 3-6. Host LUs assume the subarea address of their host processor.

All remote logical units and stations, either switched or nonswitched, assume the subarea address of the ACF/NCP/VS by which the logical unit or station is controlled. Switched LUs and stations are assigned to a particular subarea only after connection is established and only for the duration of the connection.

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<sup>1</sup>Exception: At the user's option, data may pass through intervening host processors on ACF/TCAM host-to-host data flows.

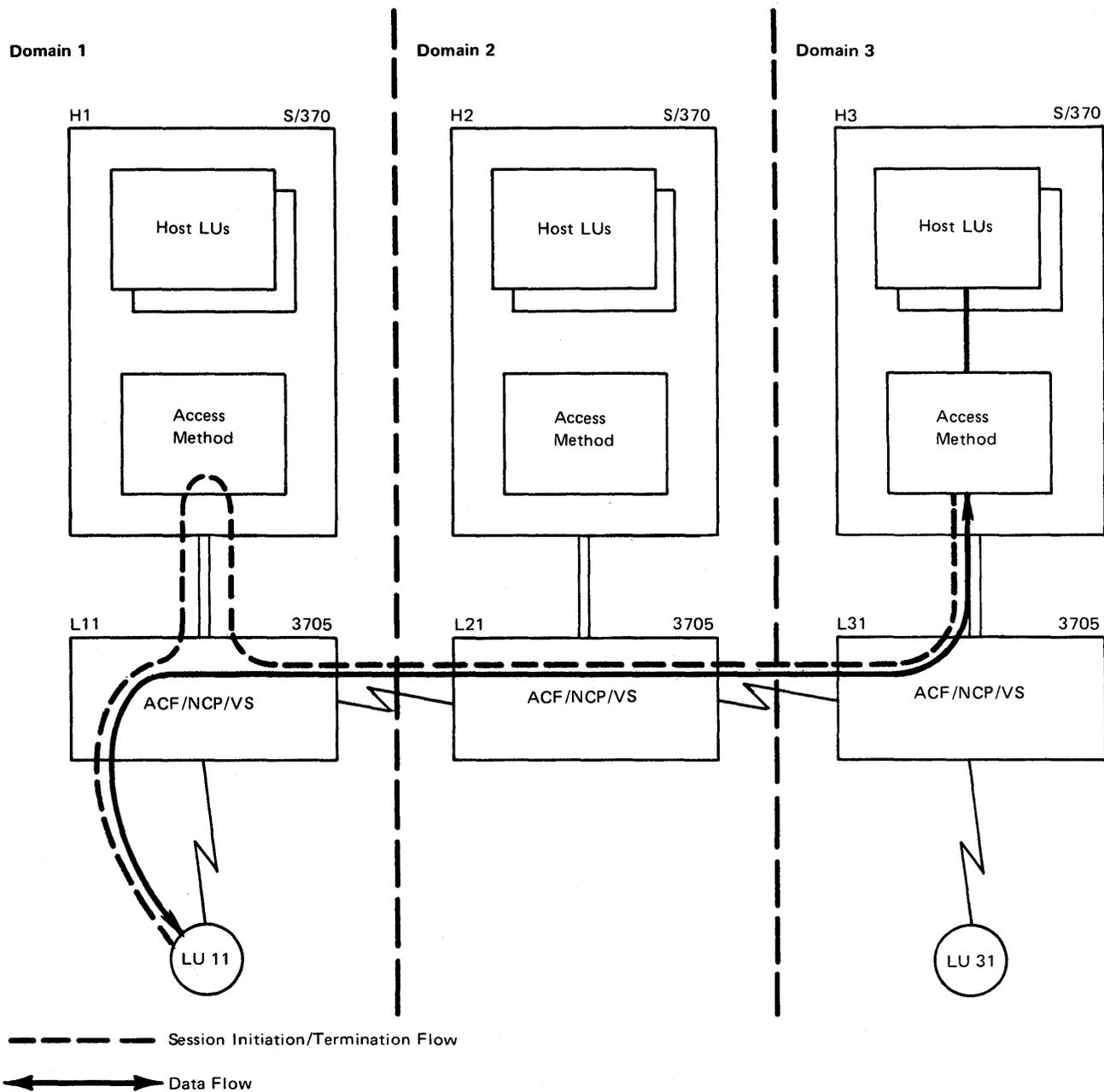


Figure 3-5. LU-LU Session Initiation/Termination and Data Flow

### Intermediate Node Routing

In a multiple-domain network, data flows only through those network elements that are specified as the path between the two end points of a session. As shown in Figure 3-7, the ACF/NCP/VS is providing intermediate node routing for a cross-domain session. The ACF/NCP/VS can perform this function because it knows the subarea routing for each cross-domain data flow that it can receive. Upon receiving the data, the ACF/NCP/VS determines the appropriate adjacent subarea for the data flow and routes the data to that subarea. Only ACF/NCP/VS can perform intermediate-node routing; neither ACF/VTAM nor ACF/TCAM provides this function. (However, ACF/TCAM message handlers, in conjunction with ACF/TCAM host-to-host data flows, can be used to route data through an intervening host processor.)

Figure 3-8 shows a data link between two communications controllers in the same domain. Such a link, called a *same-domain link*, allows the ACF/NCP/VS in both controllers to provide intermediate-node routing.

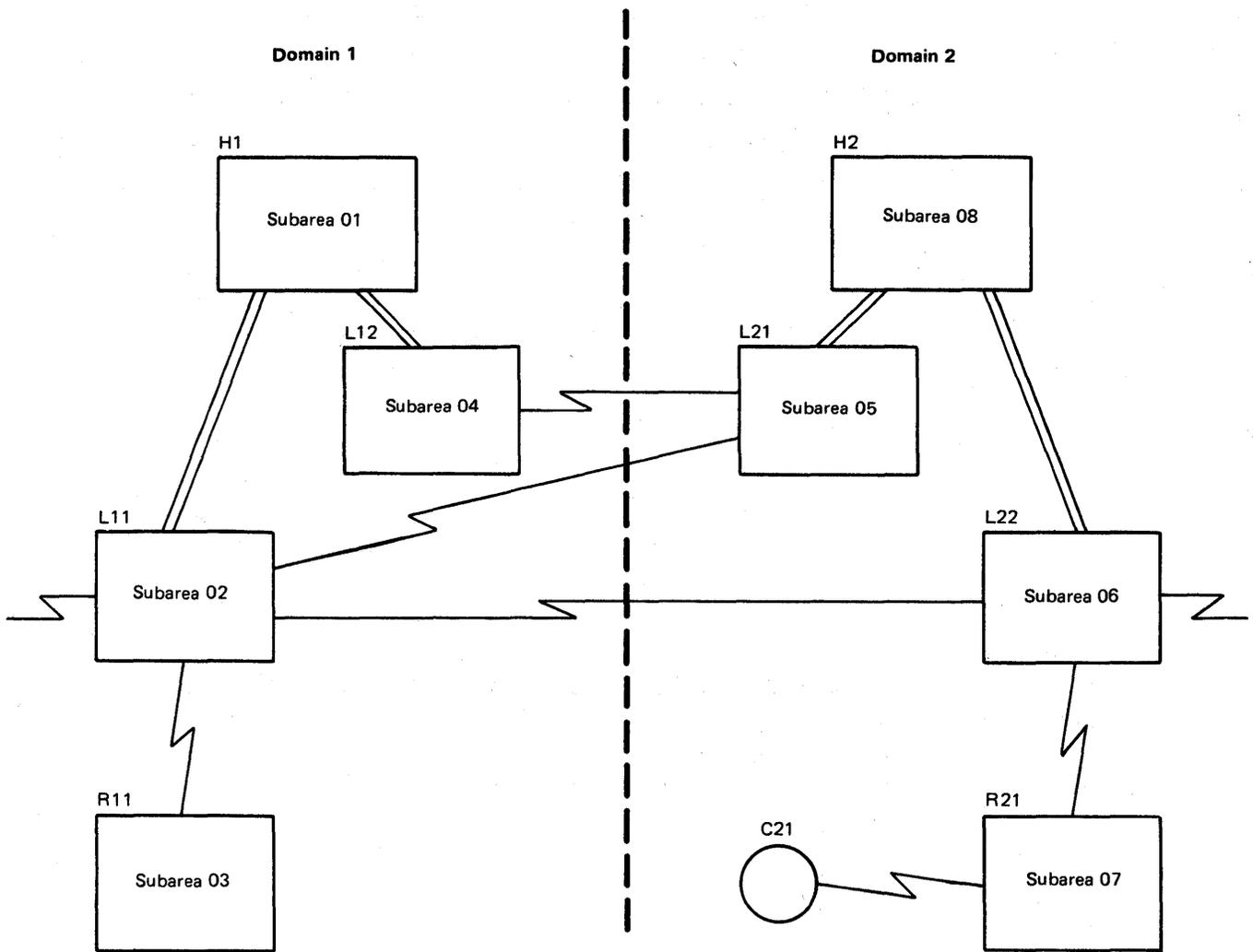


Figure 3-6. Configuration Having Multiple Paths Between Domains

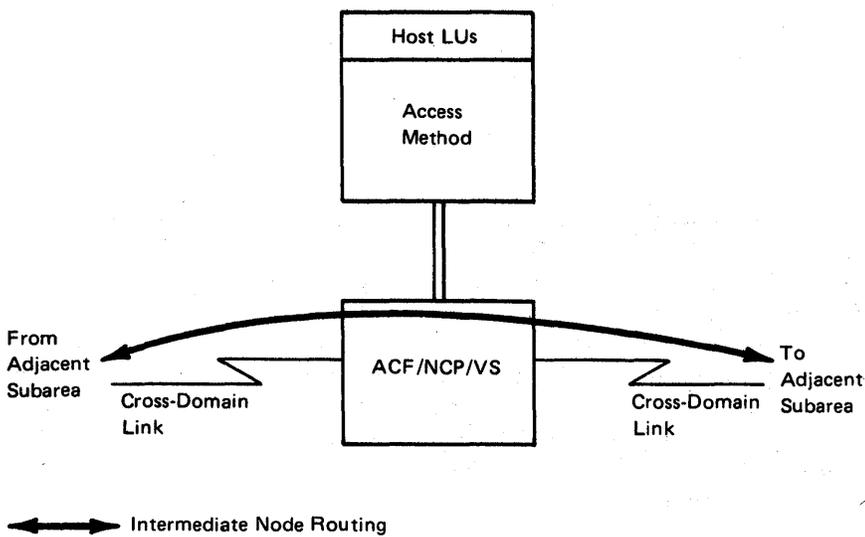


Figure 3-7. Intermediate Node Routing by ACF/NCP/VS

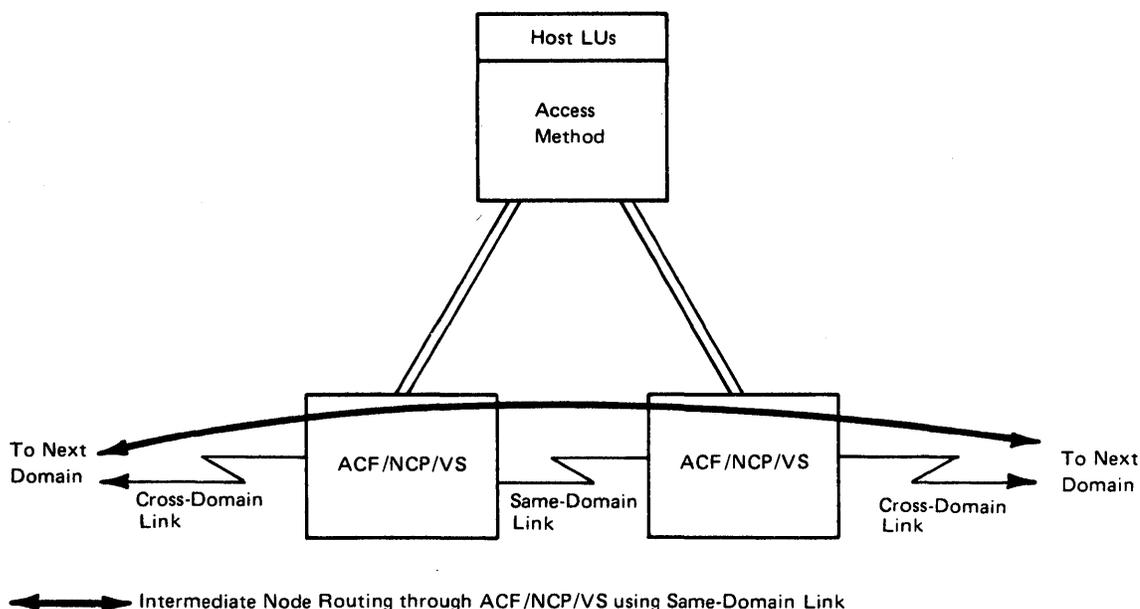


Figure 3-8. Intermediate Node Routing Between Local Communications Controllers in the Same Domain

### Sharing Network Resources

The key capability provided by networking is extended sharing of resources in a multiple-host, multiple-location environment. For purposes of discussion in the following paragraphs, a four-domain, multiple-system network, shown in Figures 3-9 through 3-11, is used to demonstrate cross-domain sharing. The configuration shown includes:

- A communications controller (L11) attached by data channels to host processors H1 and H2 using the multiple-channel attachment facility
- Cluster controller C32/41 on a switched line that can dial into, or be dialed by, communications controllers L31 and L41
- Cluster controller C31 with two logical units, LU H and LU K, associated with the cluster controller.

The access methods in host processors H1, H2, H3, and H4 can be any combination of ACF/VTAM or ACF/TCAM with the Multisystem Networking Facility. The host operating systems can be either OS/VS1 or OS/VS2 MVS, or in the case of ACF/VTAM, DOS/VS. To use the multiple-channel attachment of communications controller L11, host processors H1 and H2 are at the same location. Host processors H3 and H4 can be at any locations.

Networking allows host LUs to communicate with other LUs in any part of the network, subject only to user-defined authorization. Networking can therefore eliminate redundant host LU functions and redundant special-purpose communication lines. Networking can also allow backup of critical host LU functions or devices.

How multiple-host LU functions can be avoided is illustrated in Figure 3-9. Host LU 2 in processor H2 can be shared by users in all domains: the function represented by LU2 need not be executed in each host processor. The heavy dashed lines in Figure 3-9 indicate the path required for session initiation and termination. After session initiation, data flows directly between the host LU and the station (logical unit).

Dedicated single-purpose data links can be replaced by shared links. For example, without networking, if logical unit LU B in domain 1 of Figure 3-9 needs to use a host LU in domain 3, a special connection for that purpose has to exist between the domains 1 and 3. (In these descriptions, domain 1 is the domain whose system services control point [SSCP] resides in host processor H1, etc.) Similarly, if a user of logical unit LU F in domain 4 needs to use a host LU in domain 2, a special connection has to be provided. With networking, a set of common shared links are used rather than multiple special-purpose connections. The shared links permit complete access to host LUs in any domain by all cross-domain LUs in the network.

Figure 3-10 shows two LU-LU sessions in parallel between the same pair of host LUs: LU 1 in host processor H1 and LU 2 in host processor H2. Multiple sessions between the same pair of LUs are possible if the access methods in both host processors are ACF/VTAM Release 2 (or higher release level). Multiple sessions between ACF/TCAM application programs are possible if one of the application programs is represented by a separate LU for each session.

For these sessions between host LUs, the paths for session initiation and data flow are the same. Also shown in Figure 3-10 is a session between host LU 2 and logical unit LU H in the domain of host processor H3 and a session between host LU 2 and logical unit LU A in a cluster controller (C11) channel-attached to host processor H1. The access method in host processor H3 participates in session initiation between LU H and host LU 2, although the session-initiation path is not shown. The heavy solid lines in the figure show the data flow after the sessions are established.

If a cluster controller contains multiple logical units, those logical units can be concurrently in sessions with host LUs in different domains. In Figure 3-10, logical unit LU H is in session with host LU 2 while logical unit LU K is in session with host LU 3.

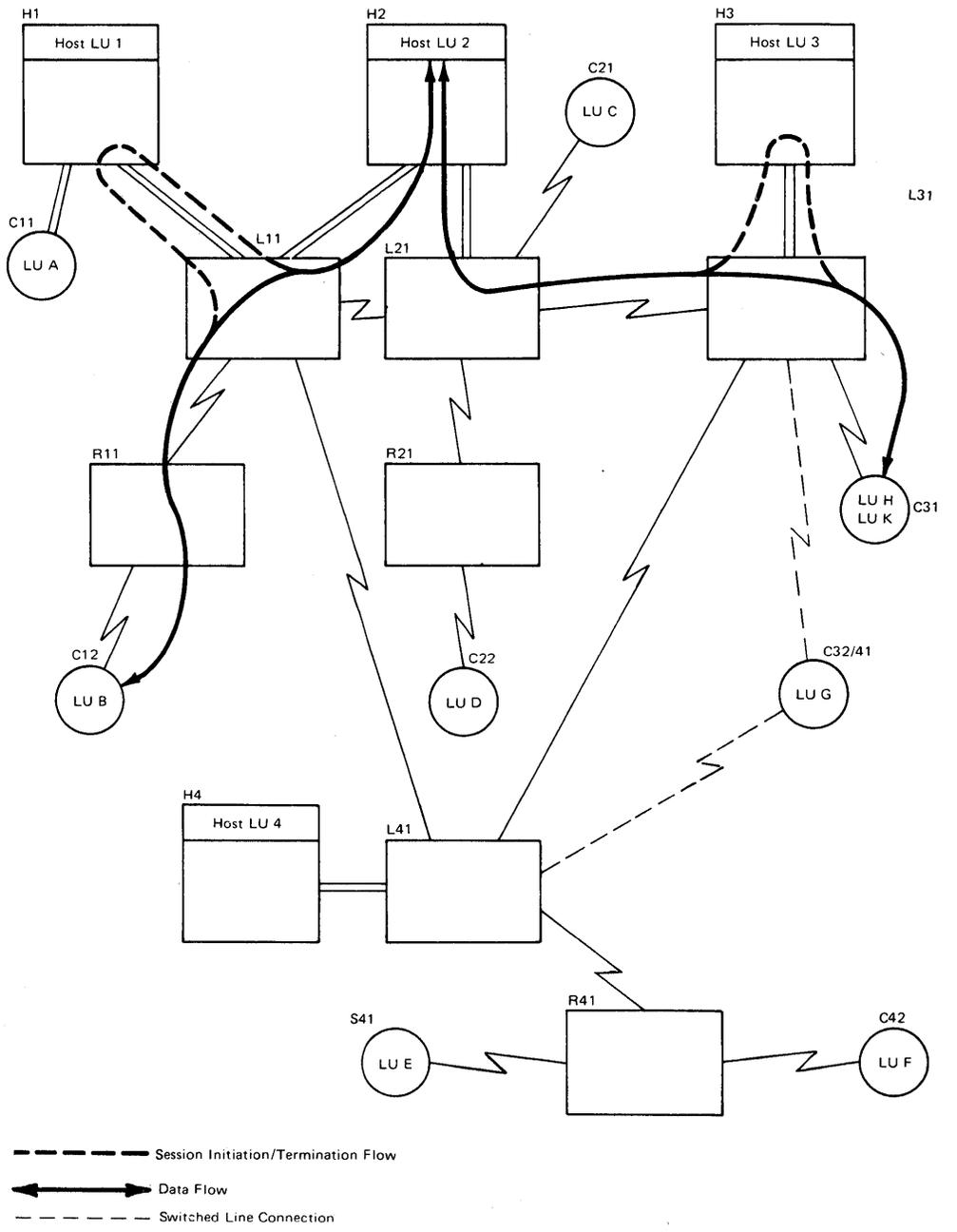


Figure 3-9. Sharing a Host LU

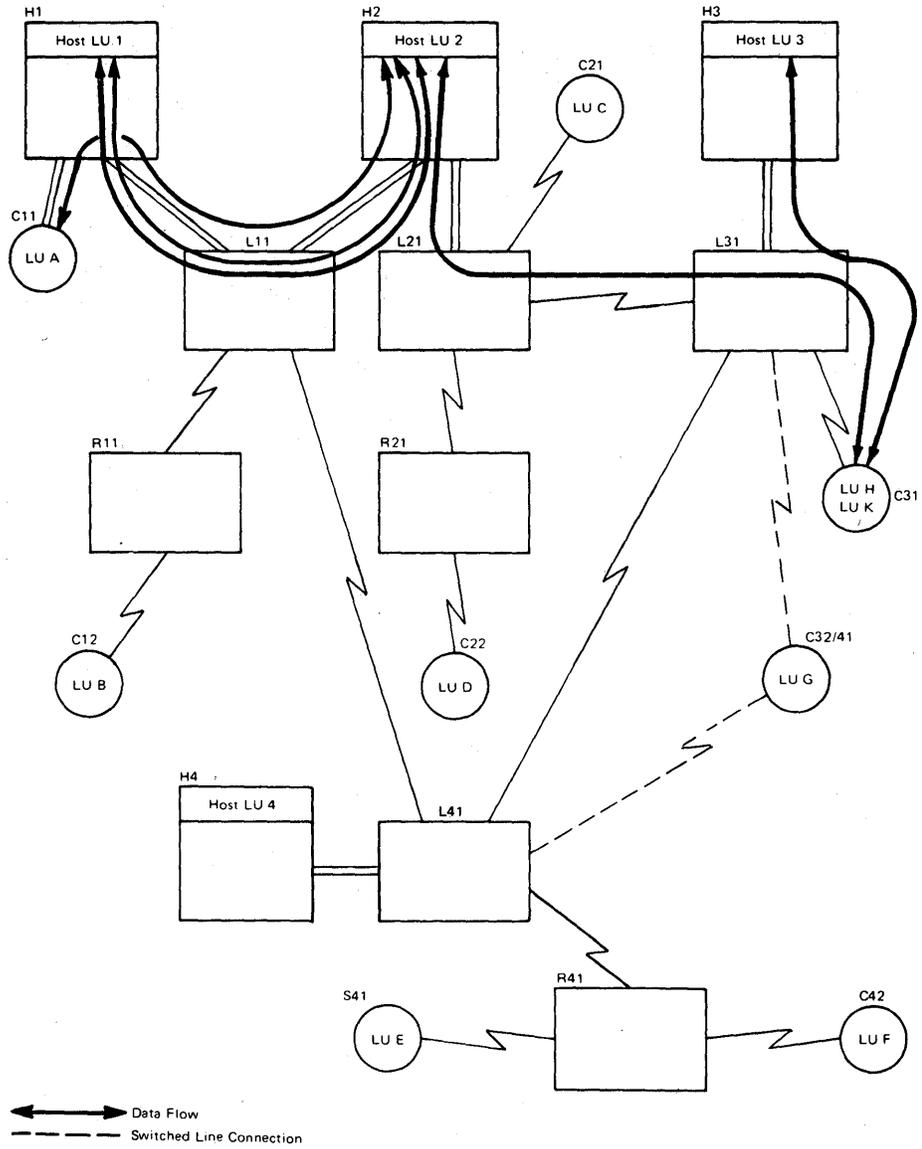


Figure 3-10. Access to Resources across Domains

A session can span intervening domains. For example, in Figure 3-11, a session between logical unit LU E in domain 4 and host LU 2 in domain 2 crosses intervening domain 3 using the intermediate node routing capability in communications controllers L41 and L31. Again, the heavy solid line shows data flow after session establishment. The light dashed lines between cluster controller C32/41 and communications controllers L31 and L41 indicate that the cluster controller is on a switched line and can dial into, or be dialed by, either communications controller L31 (domain 3) or L41 (domain 4). The cluster controller resources (PU and LUs) will be owned by the SSCP in whichever domain the cluster controller dials into.

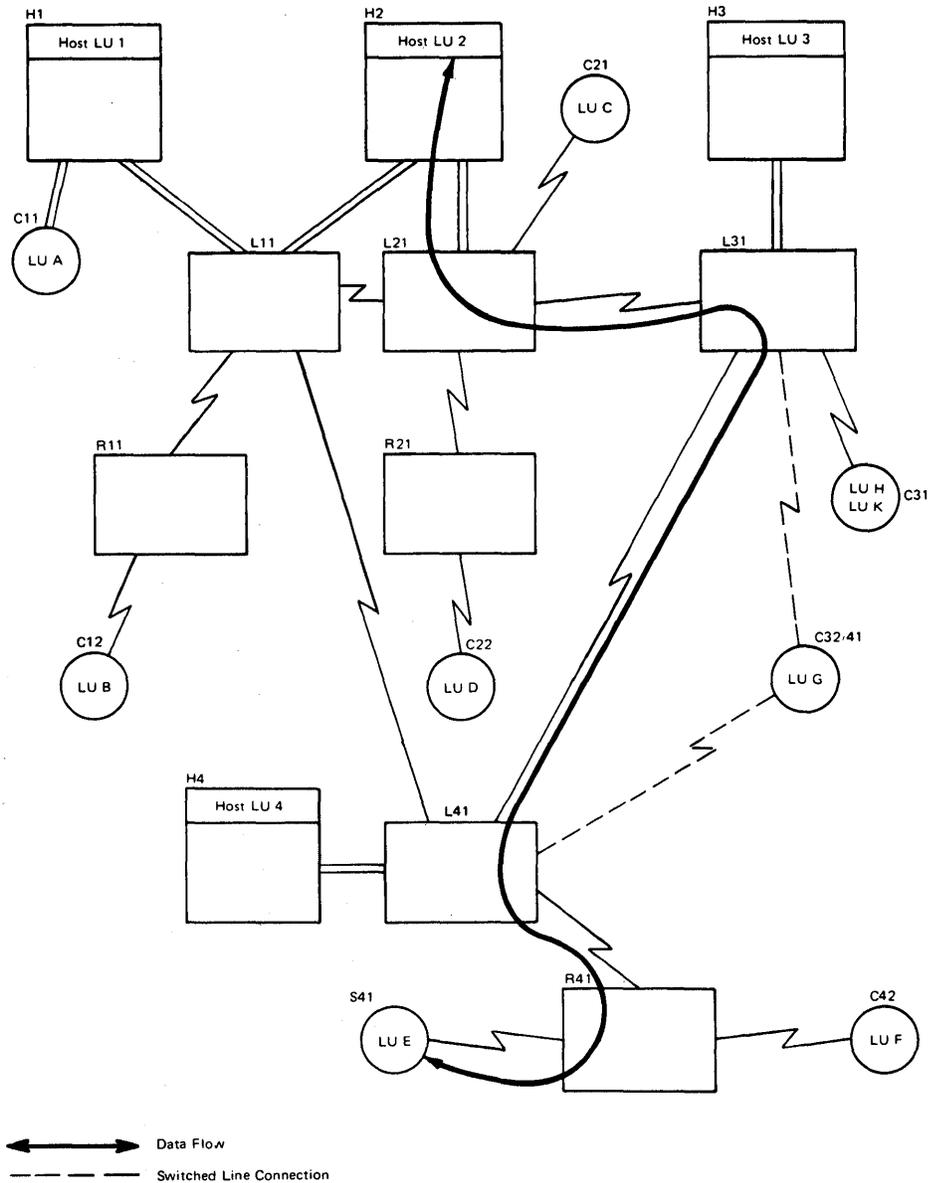


Figure 3-11. Data Flow Through an Intervening Domain

### ***Use of a Router or Message Handler***

A user-written ACF/VTAM router application program or an ACF/TCAM message handler can be used to provide cross-domain communication for stations not eligible for cross-domain sharing. Ineligible stations for ACF/VTAM include local non-SNA stations and remote non-SNA stations. (Exception: Local 3270s and non-SNA stations supported via the Network Terminal Option *are* eligible for cross-domain sharing.) Ineligible stations for ACF/TCAM include local non-SNA stations and remote stations on lines operating in emulation mode. The ACF/TCAM message handler is insensitive to whether the routing is across domains or within the same domain.

An example of an ACF/VTAM router application program or an ACF/TCAM message handler is shown in Figure 3-12. The purpose of the router in host H1 is to relay messages between one or more stations and one or more host LUs in other domains (or in the same domain). The router in host H1 is concurrently in session with logical unit LU A in local cluster controller C11, remote non-SNA station S11 in domain 1, and host LUs in hosts H1 and H3.

The characteristic that differentiates this routing capability from networking is that the data flow from the non-networking station or LU is to a host LU (the router) in its own domain. The cross-domain session is provided by the router.

### ***Implementing a Communication Management Configuration***

Users having multiple System/370 computers controlling several data communication networks can consolidate many of the network management functions for all networks into a single processor, thereby freeing other processors at the same location for application processing.

Figure 3-13 shows a possible implementation of such a configuration with host H1 and communications controller L1 providing the communication management function. In this configuration all network resources other than host LUs and local stations belong to host H1. These resources include remote communications controllers, data links, and remote cluster controllers and terminals. Host H1 is responsible for such network management functions as activation, session initiation/termination, configuration changes, and deactivation. Hosts H2, H3, and H4 are attached by channels to communications controller L1 using the multiple-channel attachment facility of the 3705-II and the shared ACF/NCP/VS capability. Since most network management functions are performed by host H1, hosts H2, H3, and H4 can be dedicated primarily to application processing. The access methods in use can be any combination of ACF/VTAM or ACF/TCAM with the Multisystem Networking Facility. The access method in each of the hosts H2, H3, and H4 is required to provide the connection between its host LUs and the network resources using the shared ACF/NCP/VS capability of communications controller L1. The entire configuration can be interconnected with other domains, making possible full networking participation with the interconnected domains.

Since all host processors are System/370 computers with either DOS/VS, OS/VS1, or OS/VS2 MVS (as appropriate for the access method), any excess processing capability in any host processor is readily available for other applications. If required, the communication management function can be taken over by one of the application processors. As with the choice of operating systems, the model of computer required for the communication management configuration can be any model that is supported by the access method and is consistent with operational requirements.

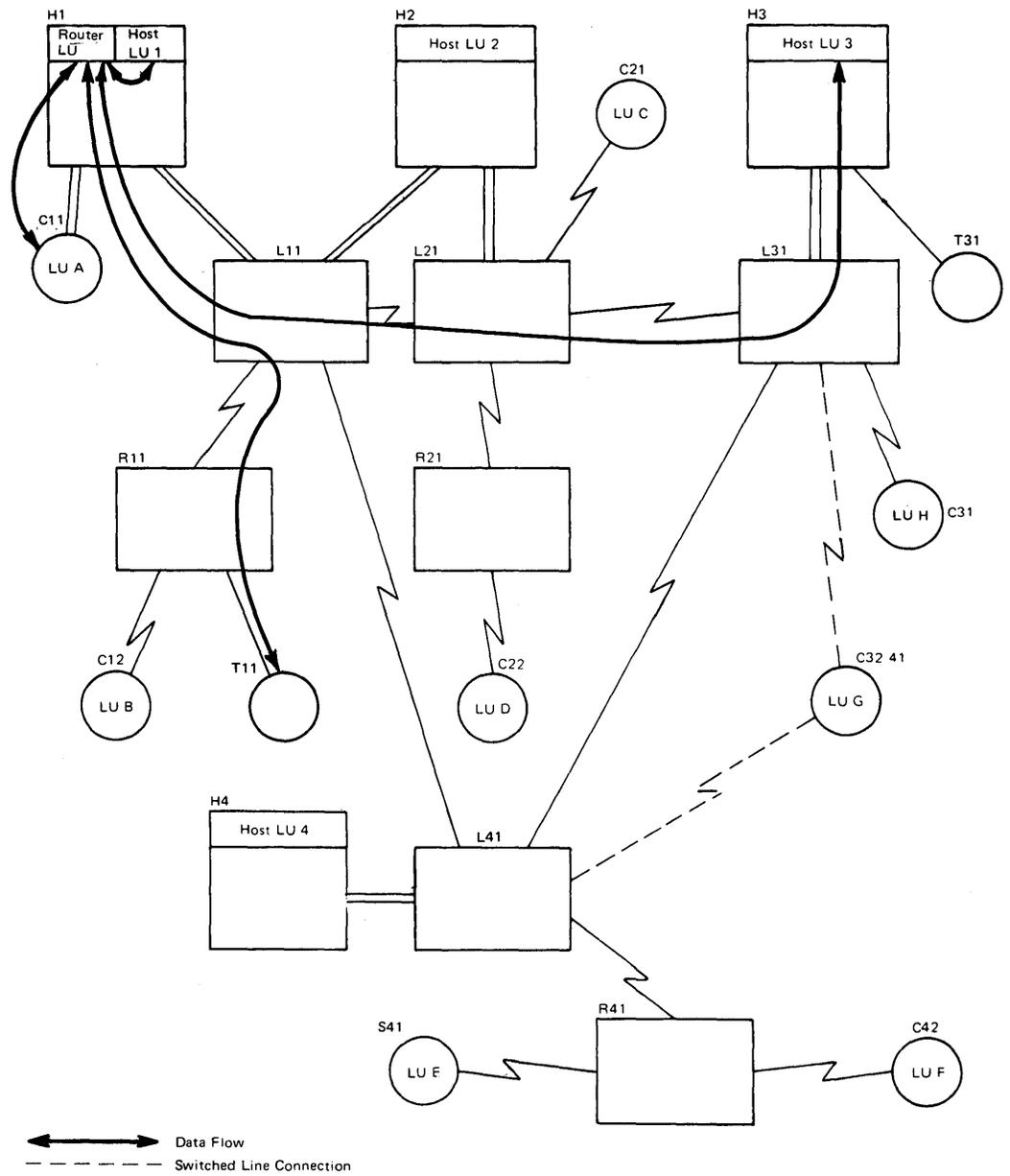


Figure 3-12. Use of a Router or Message Handler

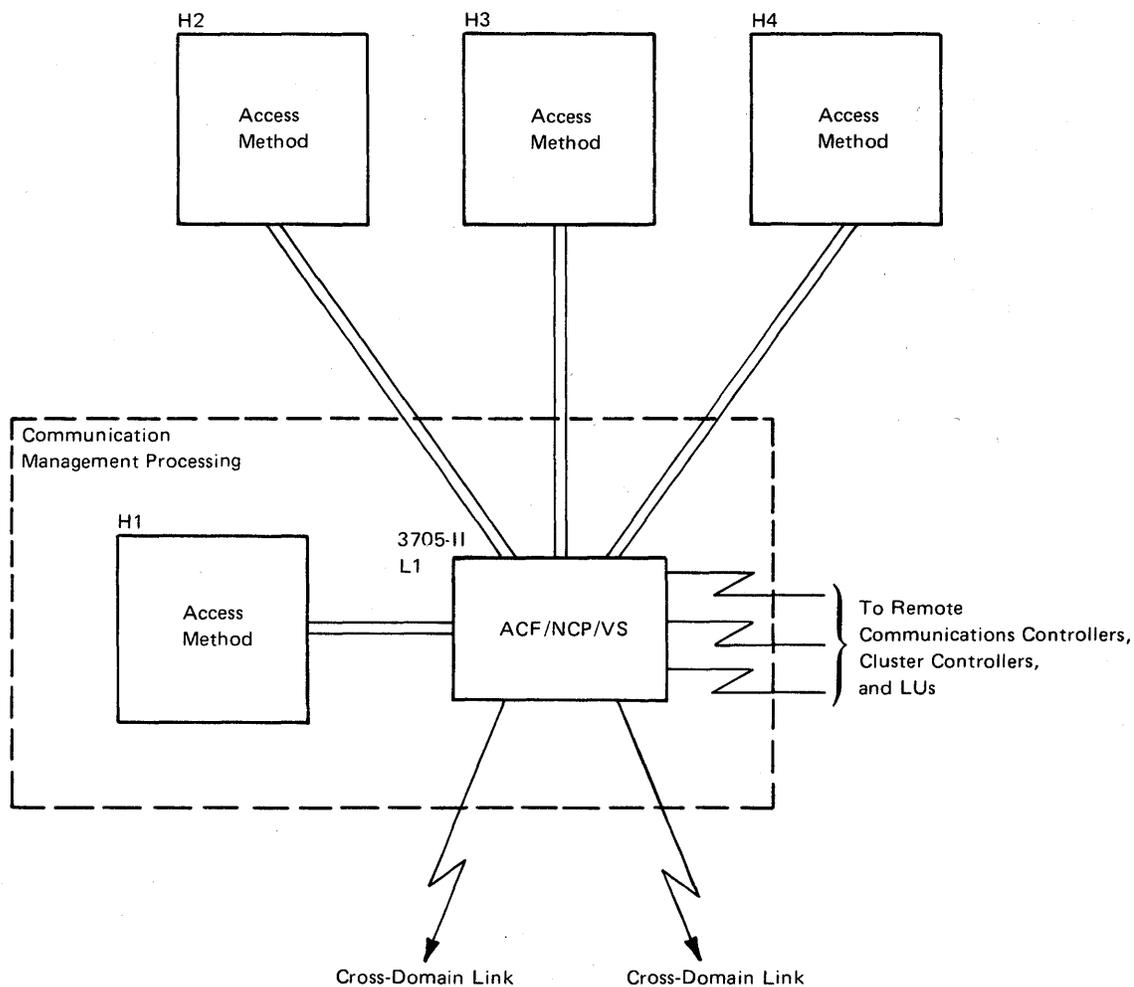


Figure 3-13. Possible Implementation of a Communication Management Configuration

## Network Control

Complex networks impose significant problems in the area of network control. The solutions to these problems require careful analysis of network requirements, proper selection of user options available when defining the network structure, and development of operational procedures for controlling the network that will effect the desired results under both normal and recovery conditions.

ACF/VTAM and ACF/TCAM include operator commands and status displays for use in controlling each single-domain network. In addition, ACF/VTAM and ACF/TCAM provide status displays of all resources identified as cross-domain resources. The operator commands and status displays can be used with operational procedures to control all network elements in single and multiple domains under all network conditions with minimum disruption to established LU-LU sessions. Options that are available when the network is specified include:

- Selection and identification of same-domain and cross-domain resources
- Predefined backup configuration definitions
- Routing paths
- Symbolic names for same-domain and cross-domain resources.

ACF/VTAM allows an authorized application program (a *program operator*) to issue network operator commands and to receive appropriate responses. ACF/VTAM program operators can use this facility in cross-domain sessions to permit an operator in one ACF/VTAM domain to control resources in another ACF/VTAM domain. In addition, three complementary program products are available for use with single-domain or multiple-domain network configurations. One of these is the Network Operation Support Program (NOSP), which is available only for ACF/VTAM.

The other two program products are the Network Communications Control Facility (NCCF) and Network Problem Determination Application (NPDA). They may be used by either ACF/TCAM or ACF/VTAM users to aid in controlling network operation and to handle problem determination. (NCCF is the successor to NOSP; NCCF includes the facilities provided by NOSP and offers additional facilities as well).

Detailed information on the benefits of these program products can be found in their respective General Information publications, which are listed in the Preface.

ACF/TCAM is similar to ACF/VTAM in that it permits any authorized station or application program to issue operator control commands and effect cross-domain operator control with other ACF/TCAM domains.

### ***Availability and Recovery in a Multiple-Domain Network***

The characteristics of the multiple-domain networking environment make it possible to maximize the availability of network resources. Continuity of LU-LU sessions is preserved whenever possible. When a network element participating in an online application becomes inactive because of a failure or deactivation, an alternative element, if available, can continue to support that application.

### **Continuation of Intermediate Node Routing Function**

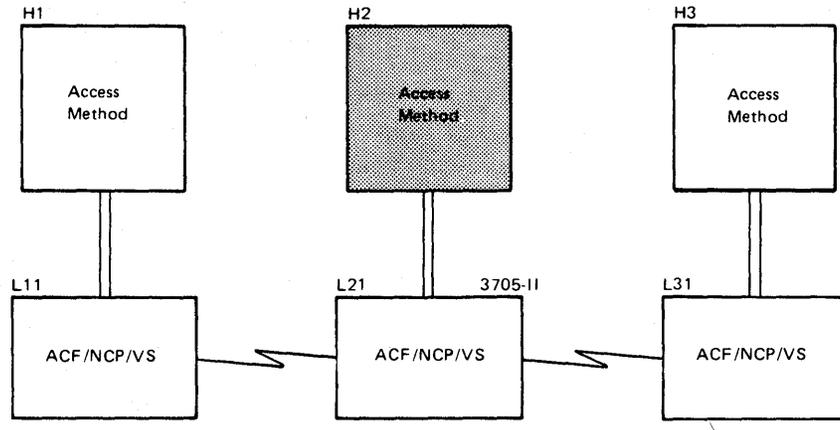
Assume that host processor H2, in the configuration shown in Figure 3-14 (a) fails or is deactivated, and that communications controller L21 remains active. Upon loss of contact with host processor H2, controller L21 enters automatic network shutdown mode. During shutdown, cross-domain links remain active, and cross-domain sessions using the intermediate node routing function of controller L21 between host processors H1 and H3 may continue. Cluster controllers and LUs on nonswitched lines in domain 2 (host processor H2) optionally can be allowed to continue cross-domain sessions with host processors H1 and H3.

Upon recovery, host processor H2 will activate communications controller L21. The recontacting procedure does not require reloading the ACF/NCP/VS. Cross-domain sessions between domains 1 and 3 through controller L21 are not affected by the restart.

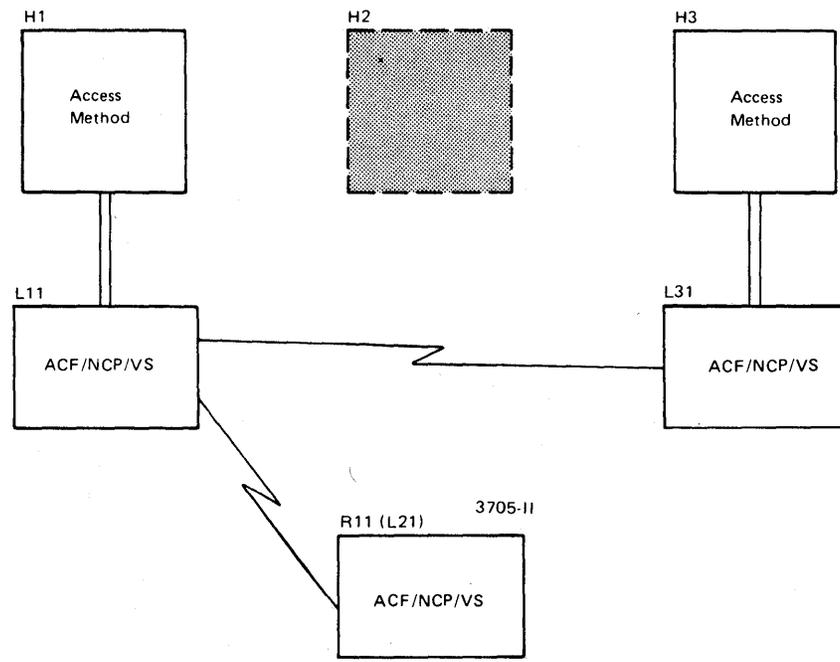
### **Host Processor Backup Capabilities**

There are several options for establishing backup host processor relationships. These capabilities are especially useful in the event of a host processor failure but can be useful in other situations as well. These capabilities are:

- Taking over the resources of a communications controller by an adjacent-domain host processor
- Reconfiguring a local 3705-II communications controller to become a remote communications controller
- Connecting a remote communications controller to a local communications controller other than the one to which it was originally connected.



(a) Continuation of Intermediate Node Function



(b) Local/Remote Switchover

Figure 3-14. Recovery from Host Processor Failures

**Resource Takeover by an Adjacent-Domain Host Processor:** An operating local communications controller and its resources can be taken over by an access method in an adjacent domain. An adjacent domain is one that either shares a multiple-channel-attached communications controller, or is one cross-domain link away. Following acquisition of the communications controller by the access method in the new host processor, the resources of the communications controller may be activated incrementally. The takeover may be staged so that cross-domain sessions are not disrupted. The capability of ACF/NCP/VS to be shared by multiple SSCPs allows the takeover to be shared by multiple adjacent-domain host processors. Cross-domain links can also be taken over by a host processor performing the backup function.

**Local-to-Remote Reconfiguration:** The optional local/remote capability of the 3705-II communications controller allows a local communications controller to be taken over from another host processor as a remote communications controller in the new domain, as illustrated by Figure 3-14 (b). This action changes the characteristic of the 3705-II from a local communications controller (L21) in domain 2 to a remote communications controller (R11) in domain 1. The changeover is initiated by an operator from the domain of the host processor taking over the communications controller and requires that the controller be reloaded. As a remote communications controller, the 3705-II does not support any cross-domain links. If the cross-domain link between communications controllers L11 and L31 is desired, the link can be manually dialed and both L11 and L31 reloaded with updated path routing information.

**Connecting a Remote Communications Controller to a Different Local Controller:** A remote communications controller can be connected to a different local communications controller in the same or a different domain, if the receiving communications controller has the proper network address defined in its ACF/NCP/VS. This action is accomplished by activating a data link to a new local communications controller and reloading the remote communications controller. If the changed remote communications controller is given a different subarea address, neither local communications controller needs to be reloaded.

### **Communications Controller Backup**

If a local communications controller becomes inoperative, the inoperative condition is detected by all adjacent network elements. Only sessions requiring access to the inoperative communications controller are disrupted. If a remote communications controller is connected to the inoperative local controller, the remote controller enters automatic shutdown mode. Logical units may clean up processing for that session and wait for network recovery. The network operator may intervene, to recover the capabilities of the inoperative controller, by either reloading the communications controller or manually switching to a backup communications controller.

### **Cross-Domain Link Backup**

The network operator can effect recovery from inoperative cross-domain links by activating a backup nonswitched link or by manually dialing a switched backup link. Network operator intervention is required in both domains to initiate activation of the appropriate cross-domain link. The communications controllers at each end of the failed link do not require reloading. The only disruption is to cross-domain sessions that use the failing link. The logical units for such sessions are notified of the failure if that failure has not also disrupted the SSCP-PU and SSCP-SSCP sessions used to notify SSCPs of the disruption of the cross-domain session.

### *Coexistence and Migration with a Multiple-Domain Network*

The networking (multiple-domain) environment that the Multisystem Networking Facility of ACF/TCAM and ACF/VTAM makes possible does not affect the coexistence possibilities described in Chapter 2 for single-domain environments. Since the multiple-domain environment simply comprises two or more single-domain environments combined, the ability to have TCAM, VTAM, and other non-ACF access methods and NCP/VS applies also to a multiple-domain network. All non-ACF access methods and non-ACF NCP/VS will function independently of the domains managed by ACF/TCAM and/or ACF/VTAM. Coexistence extends also to the operating systems under which the access methods function. The host processors in a multiple-domain environment can operate under any combination of operating systems (OS/VS1, OS/VS2 MVS, DOS/VS) that accommodate the access methods employed in the host processors. The processors can be any models that are supported by the operating system and the access method that occupy them.

Migration for multiple-domain networks can proceed in much the same way as for single-domain networks. New cross-domain application programs, however, cannot be executed until ACF/NCP/VS has been installed in each 3705 through which cross-domain sessions will pass and until the Multisystem Networking Facility has been installed in each host processor that will originate cross-domain sessions.

## Chapter 4. Capabilities of Level 3 of Advanced Communications Function

Level 3 of Advanced Communications Function consists principally of these program products: ACF/VTAM, Release 3; ACF/TCAM, Version 2 Release 3; and ACF/NCP/VS, Release 3. Used together in an SNA-based network, these programs provide significant new functions that can improve the reliability, availability, and usability of SNA-based networks. For example, the parallel link capability and the extended NCP interconnection capability enhance the reliability of the network by expanding the user's options for backup of access methods, network control programs, and SDLC links. Use of the multiple routing and the flow control capabilities of Level 3 can improve the availability of the network to carry user data by providing alternate routes for data transmission and by forestalling data congestion in the network.

This chapter describes in general terms each of the new or improved capabilities offered by the component programs of Level 3 of ACF. These capabilities are in addition to those of Level 2, as described in the previous chapters. It is beyond the scope of this publication to describe the detailed program functions that make these capabilities possible. More information on these functions as provided by the individual programs may be found in the following publications:

- *ACF/VTAM General Information: Introduction*, GC27-0462
- *ACF/TCAM General Information: Introduction*, GC30-3057
- *ACF/NCP/VS (Network Control Program and System Support Programs) General Information*, GC30-3058

The related program products, Network Communications Control Facility, Network Problem Determination Application, and Network Terminal Option, as briefly mentioned in Chapter 1, are also available for use in networks operating under Level 3 of ACF (Level 3 of ACF requires Release 2 of the Network Terminal Option).

### *Extended NCP Interconnection*

A new capability in Level 3 of ACF, called *extended NCP interconnection*, makes possible much greater flexibility in configuring a network and, in conjunction with the multiple routing capability described later in this chapter, improves the ability of a network to recover from several kinds of failures.

### **Configuration Flexibility**

Prior levels of ACF impose constraints on the location, in a network, of communications controllers and their network control programs. A communications controller can be either local to its host processor(s)—that is, attached to one or more host processor channels; or it can be remote—that is, at a distance from the host processor that precludes its being attached to a channel. The remote controller is connected to a local controller by an SDLC link. (Local controllers are also called channel-attached controllers, and remote controllers are also called link-attached controllers.)

Although a remote controller can be at any distance from a local controller, under prior levels of ACF, it cannot be connected to more than one local controller at a time, and it cannot be connected in turn to another remote controller. These constraints on interconnection limit the flexibility with which communications controllers can be geographically placed in a network and restrict the number of paths over which network traffic can flow. Figure 4-1 shows two host processors, each attached to a local communications controller and (via its local controller) to a remote controller, with the two local controllers joined by an SDLC link. Under prior levels of ACF, no other links can connect the controllers to one another.

Level 3 of ACF removes these constraints. Figure 4-2 shows the configuration of Figure 4-1 with each controller now interconnected to every other controller. More paths are available to accommodate network traffic. (The topic "Multiple Routing" later in this chapter explains the advantages of having these added connections.) Figure 4-3 shows how controllers can be joined in tandem (that is, in series) in a further extension of a mesh network. Of the 15 possible connections between controllers, 11 are shown. Few networks would require all of the possible connections.

Because controllers can be connected in tandem, they can be located anywhere in the network they are needed to accommodate concentrations of stations (such as terminals and cluster controllers) without regard for whether they must be attached to a channel-attached ACF/NCP/VS.

### Improved Network Recovery

Another major benefit of extended NCP interconnection is the improved ability of a network to recover from failures (or deactivation) of certain physical elements and programming resources in the network. The improved recovery ability results from removal of distinctions between network control programs loaded over a channel and those loaded over a link.

Prior to Level 3 of ACF, network control programs loaded over a link cannot operate links to other domains. A situation may occur in which a network control program fails in a channel-attached controller that is also link attached to other controllers. If the controller in which the failure occurred is reloaded over a link, it becomes in effect a remote controller. Although the controller is again operational, and sessions with resources it controls can be re-established, it cannot communicate with any remote communications controllers or with resources attached to those controllers. It also cannot communicate with controllers (and their resources) in other domains. A significant portion of the network may thus be lost to use for as long as the reloaded controller operates as a remote controller.

Extended NCP interconnection removes these limitations by providing the same functional capabilities for both channel-attached and link-attached network control programs. Extended interconnection also allows multiple SSCPs to concurrently share ownership of network control programs and SDLC links, regardless of where the programs and links are located in the network. For this reason, an NCP failure as described in the preceding paragraph does not require that the controller be reloaded. Improved ability to share resources, together with the availability of multiple routes between subareas (see "Multiple Routing" later in this chapter), can greatly improve the ability of an SSCP to take over control of a resource when the current owner (SSCP), or the path to that owner, has become inoperative. These capabilities, along with the SSCP restart and SSCP take-over functions described later in this chapter, can improve the availability of a network—that is, its ability to continue functioning despite temporary failures of some of its elements.

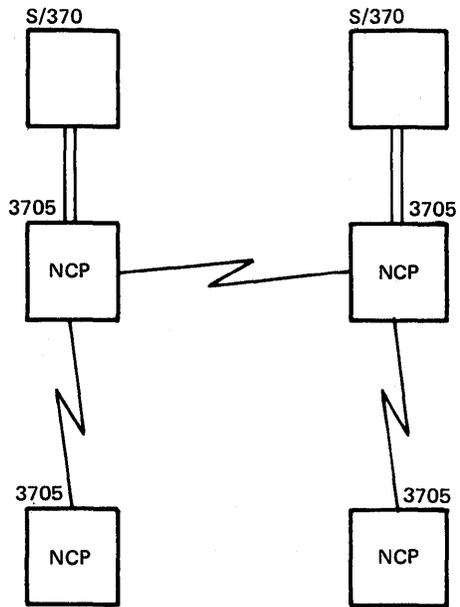


Figure 4-1. Links between NCPs Supported by ACF Level 2

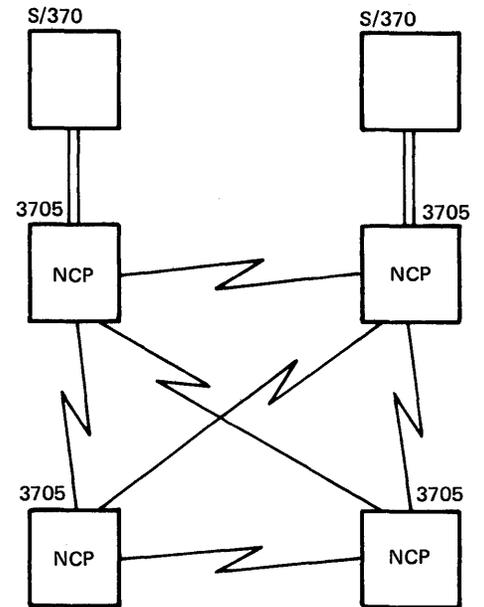


Figure 4-2. Links between NCPs Supported by ACF Level 3

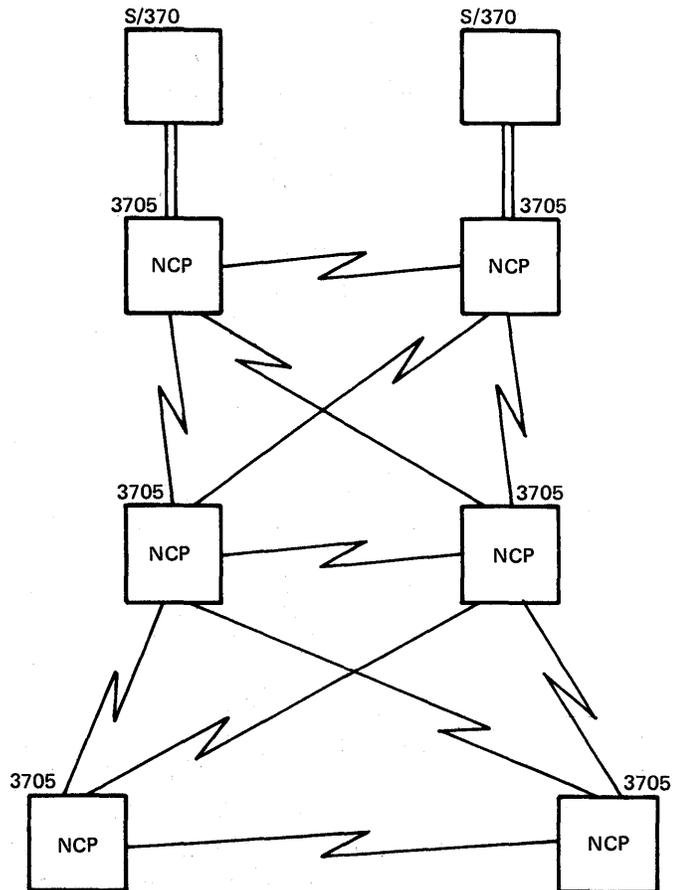


Figure 4-3. Links between NCPs Supported by ACF Level 3—Tandem Remotes Added

## *Parallel Links*

Level 3 of Advanced Communications Function provides the capability for two network control programs to communicate simultaneously over two or more SDLC links. Any number of links installed between the controllers containing the network control programs may operate simultaneously; the number of links that can be physically installed between the communications controllers in which the programs are executed is determined solely by the hardware capabilities (such as line sets) of the controllers. The characteristics of the links may differ; for example, some may be high-speed links, while others may be low-speed links. Each link can be activated and deactivated independently of the other links between the network control programs.

The parallel link capability, when used in conjunction with the transmission group capability (described in the next topic), can increase the message flow between two network control programs. Also, distribution of the total data flow among multiple links can minimize the disruption to LU-LU sessions caused by failure of a single link or by the need to deactivate a link for reasons such as maintenance or testing. The data that would ordinarily flow over the inoperative link is automatically redirected over the remaining links in the transmission group. Thus, the reliability and availability of the paths between network control programs are improved.

## *Transmission Groups*

The transmission group capability of Level 3 of Advanced Communications Function allows multiple SDLC links between two network control programs to be grouped logically to appear to the network as a single connection.

The network control program dynamically distributes the data traffic among the links in the transmission group. Failure or deactivation of any of the active links in the group (so long as it is not the sole remaining link in the group) results in automatic redistribution of data traffic among the remaining links without disruption of any of the sessions currently in progress over those links. Application programs and user (LU-LU) sessions are entirely unaware of and are not concerned with any redistribution of traffic within a transmission group resulting from a link becoming inoperative. Figure 4-4 shows five links between adjacent network control programs divided into two transmission groups.

No limit is placed on the number of links that may form a transmission group, except for any limit imposed by the line-attachment hardware of the communications controller. However, all links within the same group should have similar characteristics such as line speeds and propagational delays. This is recommended because data traffic is assigned to any available link in a group regardless of the individual link characteristics. Consider, for example, a group that includes two links, one operating at 2400 bits per second and the other at 9600 bps. While the 9600 bps link is transmitting data, any other traffic that arrives is assigned to the 2400 bps link. Depending upon the amount of data involved, it is possible that the higher-speed link could finish its current transmission and transmit the newly arrived data in less time than it would take the slower link to complete the transmission.

Two network control programs can be joined by up to eight transmission groups; any single active link can be assigned to only one transmission group at a time.

The term *transmission group* is used to represent a logical connection between two network control programs even if the "group" contains only one link. Further, the term is used to represent the logical connection between the host processor and the network control program, even though this connection consists only of a single data channel.

An advantage of the transmission group facility is that logical connections (transmission groups) between adjacent network control programs need not be associated with actual SDLC links when the programs are defined. Only when a network control program activates a particular link upon command from the access method does the link become associated with a particular transmission group. A switched link may be moved from one transmission group to another to help equalize traffic loads or to compensate for link failures.

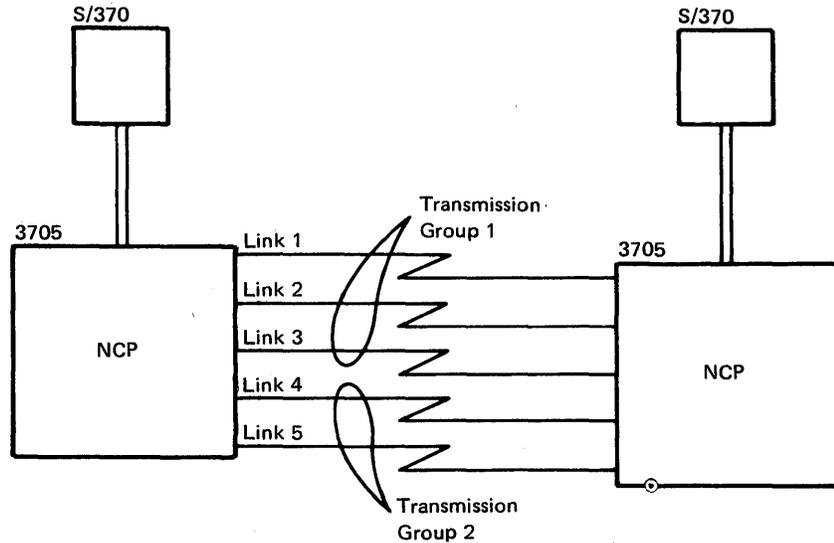


Figure 4-4. Two Transmission Groups between NCPs

### Multiple Routing

In SNA-based networks using Levels 1 and 2 of ACF, one and only one route can be active between a pair of subareas (although that route may be assigned to any of several links defined between the subareas). All data traffic sent during sessions established between those subareas must be transmitted over that single route. Any failure of a physical network element, such as a link, interrupts all sessions and their data traffic until the element is restored or another element (such as a backup link) is substituted for the inoperative element.<sup>1</sup> Then sessions must be re-established and resynchronized before transmission of user data can resume.

Level 3 of ACF provides a new capability that can improve the reliability and availability of an SNA-based network and can reduce the disruptive effect of failed elements in the network. This capability, called *multiple routing*, allows up to eight different routes to be established between a pair of subareas. Figure 4-5 shows two subareas (host processor A and network control program B) joined by four separate routes.

Each SNA session between the pair of subareas is associated with a specific route; several sessions may be associated with the same route. Figure 4-6 shows the configuration of Figure 4-5 with sessions added.

All data within a given session flows over the same route; that is, session data flow is not divided among routes.

<sup>1</sup>Exception: At the user's option, ACF/TCAM host-to-host data flows can be used to re-route message traffic around failed network elements.

The availability of multiple routes allows the total number of SNA sessions between a pair of subareas to be distributed among the routes. When failure of a physical element in one route makes that route inoperative, the sessions using that route are disrupted.

Because the remaining routes are still operative, however, new sessions to replace those disrupted by route failure may be established over any of the remaining routes, as desired. Figure 4-7 shows how failure of one route can result in its sessions being re-established over the remaining three routes.

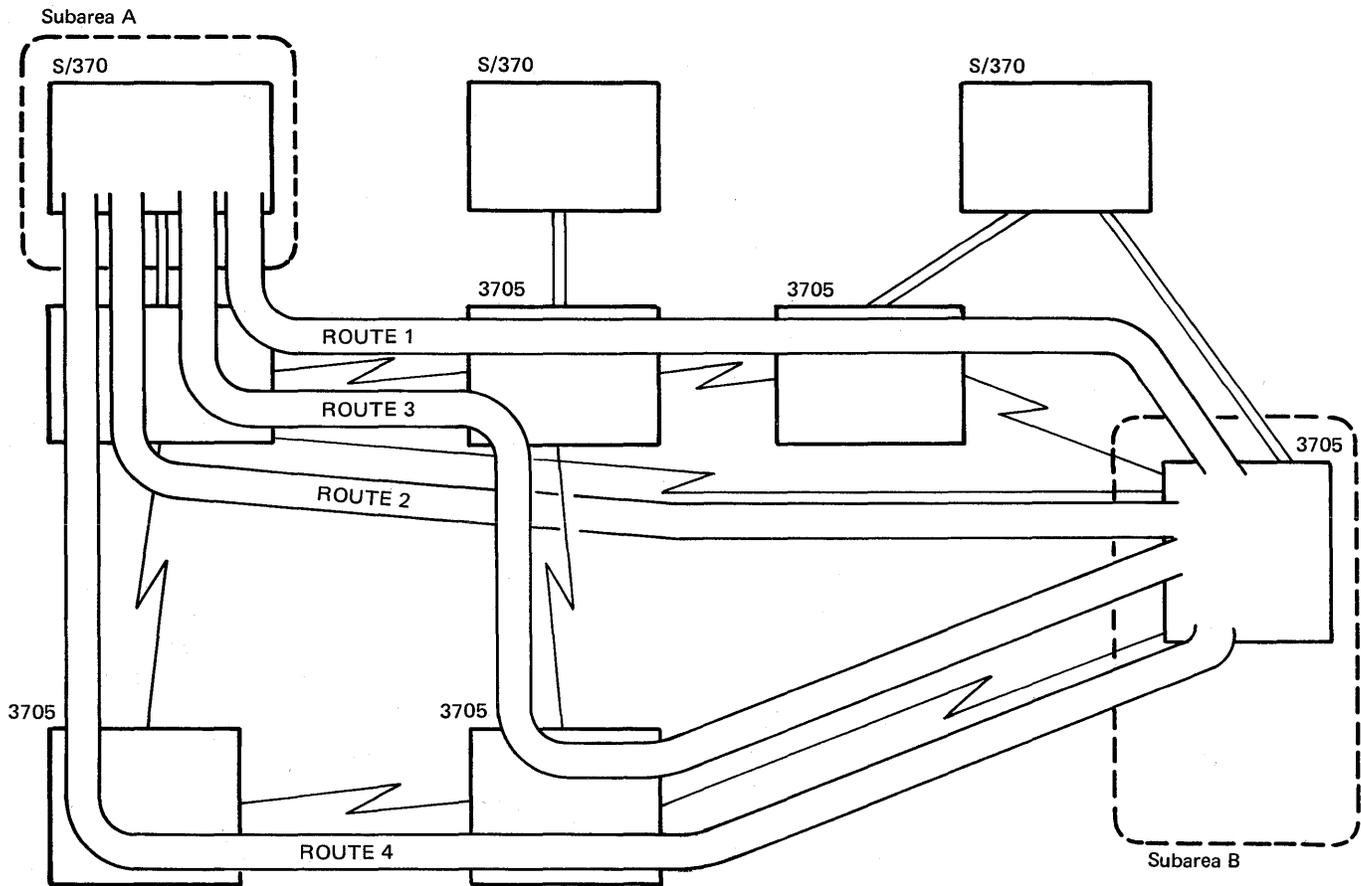


Figure 4-5. Two Subareas Joined by Four Routes

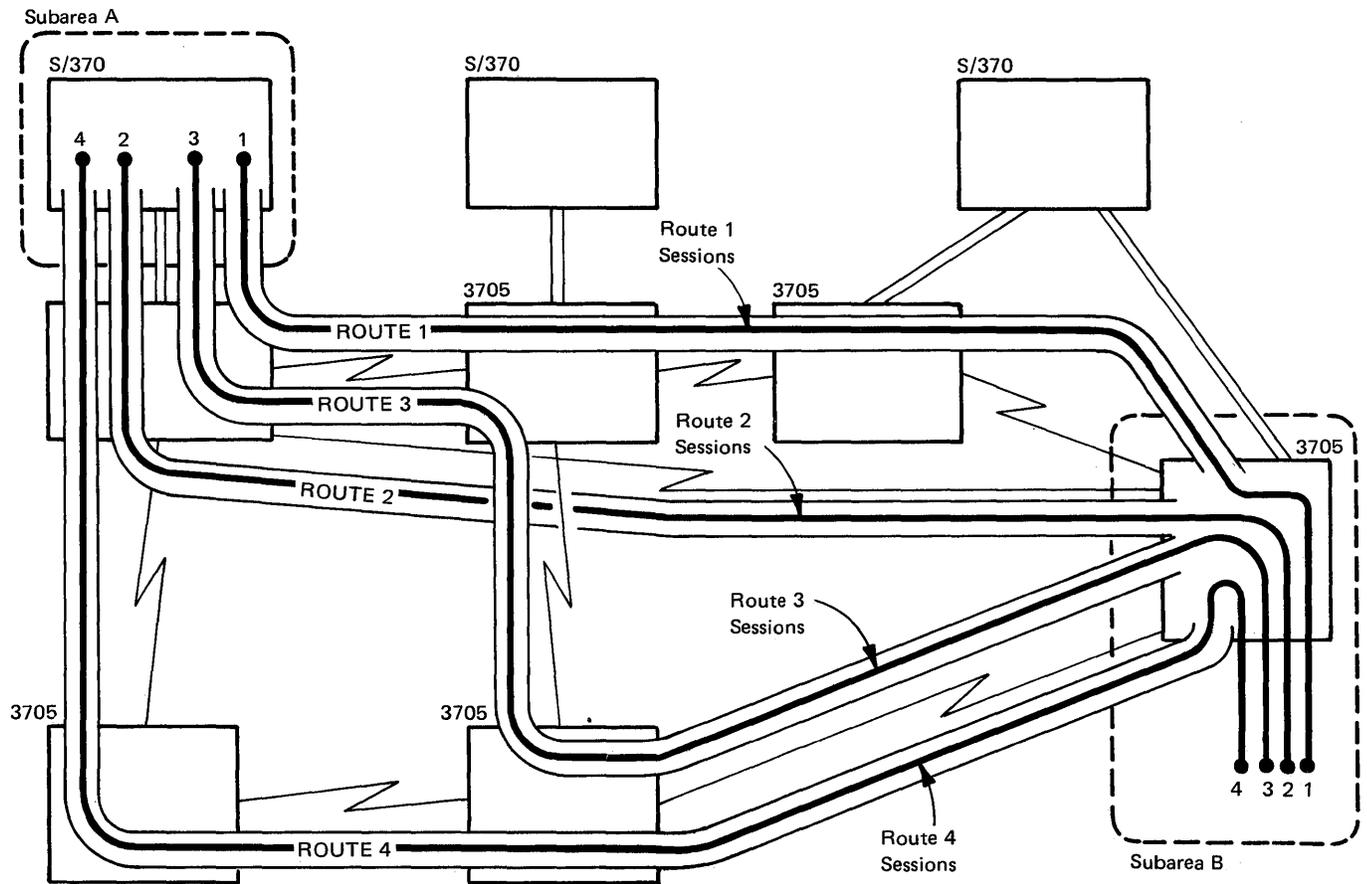


Figure 4-6. SNA LU-LU Sessions between Subareas Distributed over Four Routes

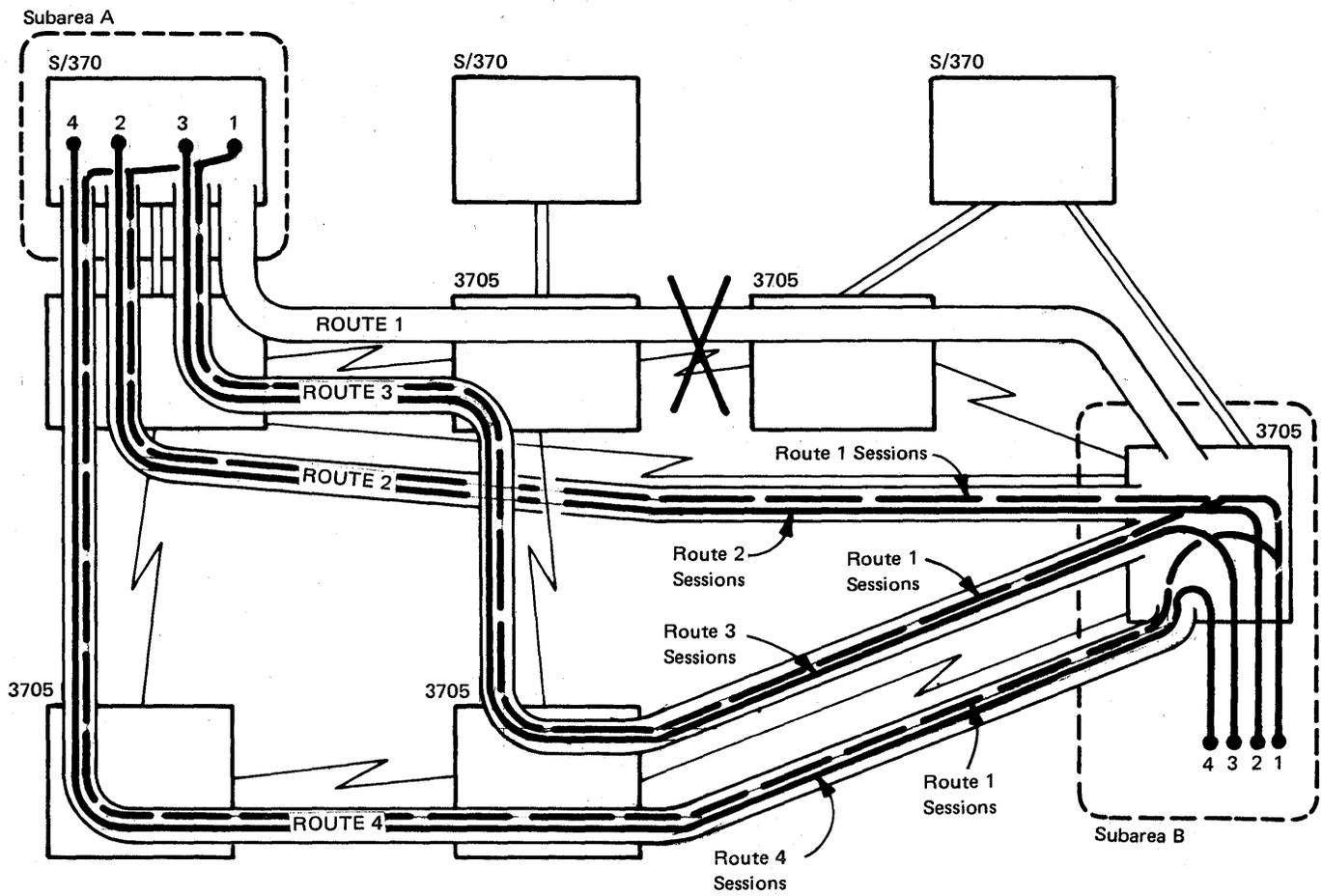


Figure 4-7. SNA LU-LU Sessions of a Disrupted Route Distributed over Remaining Operational Routes

## Explicit Routes and Virtual Routes

Multiple routing may be considered at two levels: a physical level and a logical level. The term applied to the physical level is explicit routing. An *explicit route* is a sequence of physical network elements over which two subareas communicate. Physical elements are host processors, communications controllers, and the transmission groups (links and channels) that connect them. Each explicit route is physically reversible, although it may have distinct names in the opposing directions. Data can flow over it in both directions.

Up to eight explicit routes can be established between any two subareas. Two or more explicit routes may have certain physical elements (or all elements) in common. For instance, a single transmission group or a single network control program may be an element in several explicit routes, as illustrated in Figure 4-8.

The logical level of routing is called virtual routing. A *virtual route* is a logical connection between a pair of subareas that participate in sessions. Each virtual route in a network is bidirectional: It is capable of passing data in both directions. Flow control operates at the virtual route level.

Each virtual route in a network is assigned to an explicit route; a given explicit route can accommodate multiple virtual routes.

Virtual routes differ from explicit routes as follows. An explicit route is a combination of physical network elements, each of which has certain data transmission characteristics, such as bandwidth and transmission rate. The reliability of an element also may be considered as one of the characteristics. The combined characteristics of all the elements that form the explicit route determine the data transmission characteristics of that route. Because a virtual route is assigned to an explicit route, it assumes the characteristics of the explicit route, with one important addition: transmission priority. Transmission priority is important for the following reasons.

Each pair of subareas may have many different network addressable units (for example, logical units), with many sessions established between the various units. The sessions may vary in their data transmission requirements. For example, inquiry-response sessions usually require faster data transmission and more predictable response times than data collection sessions. Since sessions for several different kinds of applications may be in progress over a given route, it is useful to assign priorities on a session-by-session basis to the total data flow on the route. That is, it is desirable to let data for LU-LU sessions requiring fast data flow be transmitted ahead of data for sessions in which slower data flow may be acceptable.

## Multiple Priority Levels

Level 3 of ACF allows the use of three levels of transmission priority. Each virtual route in a network is assigned, and is thus partly characterized by, a transmission priority determined by the system programmer. The three levels of transmission priority, combined with the eight possible virtual route numbers, allow the programmer to define up to 24 virtual routes between two subareas. The virtual routes assigned to a given explicit route have in common the inherent physical attributes of that explicit route. They may differ in their relative transmission priorities.

It is the responsibility of the system programmer to select the virtual route or routes whose characteristics best match the requirements of the kind of SNA session that will be established. In making the selection, the programmer must consider both the inherent

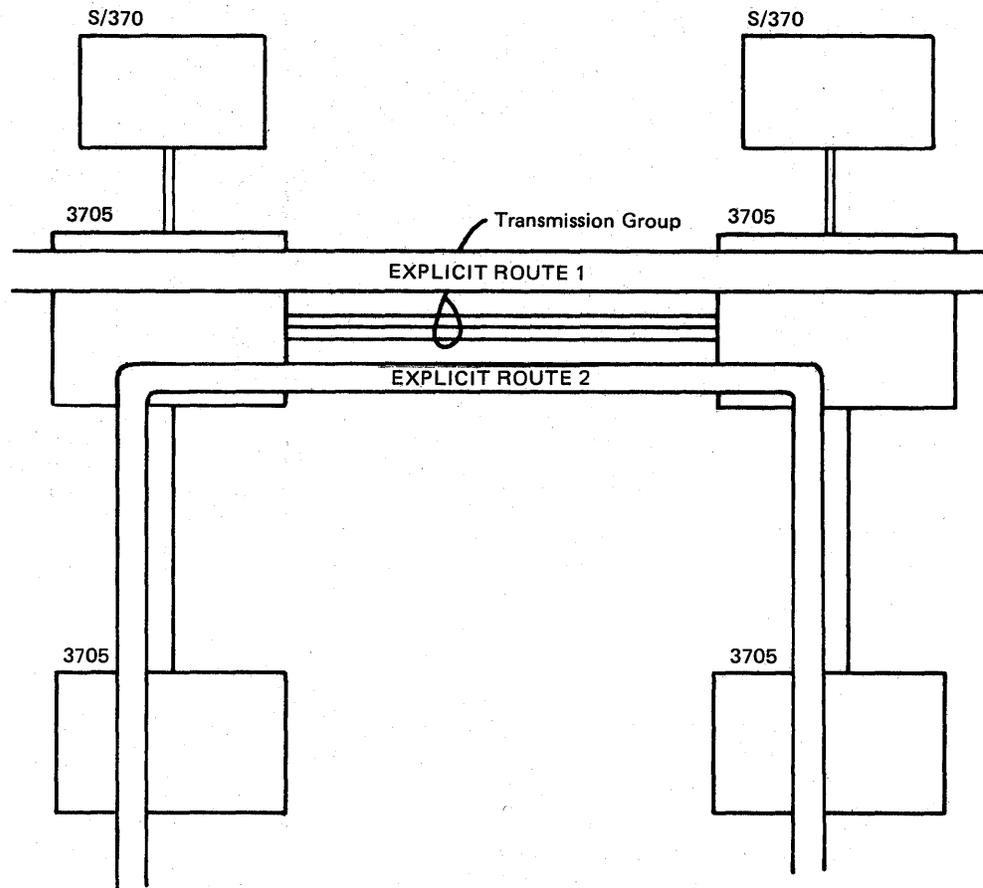


Figure 4-8. Explicit Routes Sharing Physical Elements (Two 3705s and One Transmission Group)

physical characteristics of the explicit route to be used and the transmission priority. Some explicit routes, and therefore the virtual routes that use them, may be inherently better than others. Explicit routes that comprise fewer physical elements in tandem, for example, would be typically favored over those having more elements. The longer routes might be used only for backup purposes when the shorter routes become inoperative. As another example, those explicit routes that include links of demonstrated reliability would normally be favored over those that include less reliable links.

Sometimes several virtual routes may have approximately the same characteristics and therefore be equally suitable in transferring data for a given kind of session. Level 3 of ACF allows a programmer to specify a list of several virtual routes that can be assigned to sessions. The list of one or more virtual routes represents the *class of service* furnished to any sessions that use one of the listed routes. The sequence of routes in the list is important because sessions are assigned to the first available route in the list. Routes should therefore appear in the list in descending order of desirability. (ACF/TCAM and ACF/VTAM allow the inclusion of user code to enable the order of virtual routes in the list to be altered.)

Each time a host LU requests an LU-LU session, a class of service is associated with that session. If the LU is owned by ACF/VTAM, the class-of-service name is selected from the logon mode used for the session. (The class-of-service name is added to the logon mode by the system programmer.) If the host LU is in ACF/TCAM, the LU can explicitly

specify a particular class of service on the request to initiate the session. (If none is specified, a default class of service is assigned to the session.) The class of service remains assigned until the session ends. The SSCP resolves the class-of-service name to a list of virtual routes, from which one is selected at session initiation.

The access method and the network control programs activate and deactivate virtual routes as needed. They also activate explicit routes occupied by the virtual routes. Network operators do not activate or deactivate routes of either kind, but they do activate and deactivate the physical network elements that form explicit routes.

Operators are informed if an explicit route fails. Besides identifying the failed route, the notification identifies the subarea that detected the failure and the next subarea beyond the detecting subarea along the inoperative route. This notification thus pinpoints the location of the failure so that corrective action can be taken.

If none of the virtual routes on the list of virtual routes is available, a request to establish an LU-LU session is rejected. The LU must make another attempt to establish the session. ACF/TCAM provides a virtual-route-availability monitoring function that allows the host LU to be notified automatically when a virtual route contained in the requested class of service becomes available. When the LU is notified, it automatically retries the session-initiation request.

### *Alternate Routing in the Event that a Virtual Route is Lost*

An operational virtual route may be lost because one or more of the physical elements in the explicit route to which it is assigned failed or was deactivated. In that event, the access methods and network control programs notify all logical units participating in LU-LU sessions using the route and all SSCPs involved in the SSCP-SSCP, SSCP-PU, and SSCP-LU sessions, that the LU-LU sessions have been terminated. (The topic “Session Outage Notification” later in this chapter discusses the subject of notification.) The SSCPs and the logical units can then reinitiate the sessions, assuming that the corresponding end users wish to continue communicating and that an alternate route is available.

An LU-LU session may be re-established over an available alternate route in the same class of service, or a different class of service may be specified. (For ACF/VTAM, a different logon mode is required to specify a different class of service since only one class of service is associated with a given logon mode.) If no other virtual route is available in the same or different class of service, the session cannot be re-established. A route must become available in order for the session to be re-established.

Because failure of an explicit route may cause some user data to be lost, the logical units participating in each disrupted LU-LU session must perform resynchronization processing to determine whether data loss occurred and to react accordingly.

One kind of failure in an explicit route—an SDLC link failure—does not cause LU-LU sessions to be disrupted. Because of the way data is queued for a transmission group, the failure (or deactivation) of a link in a multiple-link transmission group causes the data for all sessions using the link to be sent instead over a different link in the same group. Thus, unless the failing link was the only operational link in the group, no sessions are interrupted and no data is lost.

### **Differences in Alternate Routing for Non-SNA Stations (ACF/TCAM Users Only)**

Level 3 of ACF provides the same alternate routing capabilities for non-SNA stations as it does for SNA stations, with the following difference. In ACF/TCAM, non-SNA stations may be specified as eligible or ineligible to participate in cross-domain sessions. (In ACF/VTAM, all non-SNA stations are eligible.) A station specified as eligible is subject to the same class-of-service selection as is an LU-LU session. On the other hand, class-of-service selection is not available for a station specified as ineligible to participate in cross-domain sessions.

### ***Network Flow Control Enhancements***

The flow of data through a network varies from time to time, with the degree of variation depending on the applications for which the network is used, among other factors. In many networks, peak traffic conditions during the conduct of business can be anticipated and planned for. But traffic peaks can also result from such conditions as the failure of a route and the consequent diversion of its traffic to alternate routes. An alternate route may become overburdened with the extra traffic it is asked to carry. Unexpected demands for data transmission by certain end users (terminal operators or application programs) also may impose peak traffic conditions on parts of the network. Thus, not only does the total traffic in a network vary, but the distribution of the traffic in various parts of the network may fluctuate as well.

Whenever the rate at which data is presented to a network exceeds the capacity of the network routes over which the data must flow, data congestion results. Response times may lengthen and throughput may be impaired. Severe or prolonged congestion in one part of a network may be propagated to other parts, causing overall network efficiency to suffer.

Level 3 of ACF has several enhancements to network flow control that can limit data congestion and minimize its effect on network efficiency. On a network-wide basis, access methods (ACF/TCAM and ACF/VTAM) and network control programs continuously monitor data flow and report any congestion to network resources that are using virtual routes that include the congested elements of the network. The resources then react by limiting the amount of data they send over the affected routes until the congestion clears. The monitoring of data flow and limiting of data occur automatically, requiring action by end users.

Congestion indicators that can be set in path information units are the means of signaling the existence of congestion. For example, a network control program can set a congestion indicator if its queue for a particular transmission group is overloaded or if the program is in slowdown mode because its supply of buffers has been depleted to a predetermined point. The flow control mechanisms of access methods and network control programs in Level 3 of ACF interpret the congestion indicators and automatically modify the algorithms by which they allocate traffic to virtual routes in a way that causes the congestion to dissipate. The term *route pacing* is applied to the monitoring and flow control mechanisms that are applied to virtual routes.

Route pacing is supplemented by local flow control mechanisms that limit the amount of data that end users can present to the network for transmission. For example, congestion on a virtual route over which a host LU intends to send data is indicated to the access method by congestion indicators. The indication causes the access method to hold the data in application buffers (and, for ACF/TCAM, in disk queues) until it is informed that the virtual route is no longer congested.

### *Session Outage Notification*

Data flowing along a route in a network passes through a series of network elements, all of which must be operational. All network routes are subject to interruption through failure (or deactivation) of any of their elements. When such a failure occurs, all sessions using the affected route are disrupted, and the data flows associated with those sessions stop. The following are examples of network elements that can fail and therefore cause SNA-session disruption (also called session outage): a host access method, a host LU, a network control program, a link between network control programs (if it was the only operational link in a transmission group), a link to a station, or a station.

Many elements of an SNA-based network, such as SSCPs and network control programs, contain information about the current status of ongoing LU-LU sessions. This information normally passes along the SSCP-PU and SSCP-LU sessions associated with the LU-LU sessions. When a failure in the network disrupts an SNA session, it is important that this changed session status be communicated not only to the session partners, but also to the SSCPs of the session partners.

In networks using prior levels of ACF, the notification is communicated along the SSCP-SSCP session and along the SSCP-PU session for the network control program. Some failures, however, can disrupt the SSCP-SSCP and/or the SSCP-PU session as well as the LU-LU session. These failures thus prevent notification of session outage from reaching the SSCPs. For example, an SSCP that owns an LU for which an LU-LU session has been disrupted may not learn of the disruption and therefore be unable to allow another LU-LU session to be established with that LU.

A network under the control of Level 3 of ACF, on the other hand, does not rely on the continued existence of a SSCP-SSCP session to communicate information about disruption of an LU-LU session. Instead, when a failure (or the deactivation of a virtual route) disrupts any kind of session (SSCP-SSCP, SSCP-PU, SSCP-LU, or LU-LU), network control programs and access methods on either side of the disruption notify the session partners, all other affected SNA functions, and network operators of the occurrence of the outage.

The expanded notification that Level 3 of ACF provides affords increased opportunities for SNA sessions to be re-established, especially if alternate routes are available.

### *Non-Disruptive SSCP Restart*

In prior levels of ACF, any re-establishment of an SSCP-PU or SSCP-LU session following failure of a network element in the route used by such session disrupts any active LU-LU sessions (that is, sessions unaffected by the failure) involving corresponding LUs. In Level 3 of ACF, these LU-LU sessions are not disrupted by restarting of the SSCP-PU or SSCP-LU sessions, provided that the associated physical units are capable of being reactivated without themselves resetting their logical units. Nondisruptive restart is available only for SNA stations on nonswitched links. Sessions with SNA stations on switched links and sessions with all non-SNA stations are terminated by ACF/NCP/VS whenever ACF/NCP/VS loses its session with the SSCP that manages the stations.

## ***SSCP Takeover***

In networks controlled by Level 3 of ACF, a backup SSCP (which need not be in an adjacent domain) designated by the user can assume ownership of certain resources of a failed SSCP without disrupting any current LU-LU sessions involving those resources. The physical units associated with the LUs must be capable of being reactivated without themselves resetting their logical units. Prior levels of ACF also permit a backup SSCP to acquire resources, but in every case the LU-LU sessions for acquired LUs are disrupted, and the backup SSCP must be located in a domain adjacent to the resource it is acquiring.

Whenever the SSCP-PU session for the network control program is interrupted, the network control program informs all remaining SSCPs that own it (that is, have issued Activate commands for it) of the loss of the SSCP. The SSCPs in turn notify their respective network operators by operator-awareness messages. The operators can then perform the appropriate, installation-defined takeover procedures. (The Network Communication Control Facility program product can be useful in performing these procedures.) At a convenient time, after the original SSCP is once again active, the operators can cause the backup SSCP to relinquish the resources it acquired. The procedure is (1) terminate, at the appropriate time, the LU-LU sessions for the resources acquired by the backup SSCP; (2) relinquish the backup SSCP's ownership of those resources; and (3) re-establish the original SSCP's ownership of the resources.

## ***Network Problem Determination***

Level 3 of ACF provides improved capabilities for determining the cause of failures in a network. These capabilities, known collectively as *network problem determination* capabilities, facilitate identifying the physical elements that have failed.

## ***Route Verification***

*Route verification* allows any network operator to cause any or all explicit routes between the host subarea for which he is responsible and any other subarea to which a route is known to be tested for availability, that is, for its ability to transfer data between the subareas. The access method in the host subarea interprets the operator commands and sends test data on all appropriate explicit routes to the specified subarea. If an explicit route is operational over its entire length, the specified subarea replies to the originator of the test, which in turn notifies the network operator that the route is operational. If an inoperative physical element causes the explicit route to be operational over only part of its length, the subarea that detects the inoperative element notifies the access method from which the test originated; the access method in turn notifies the operator. The notification identifies the subarea that detected the inoperative element, the number of the transmission group corresponding to the next part of the route, and the subarea at the end of that transmission group. The notification thus isolates the failure to a specific transmission group or subarea. The subarea that detects the failure also (1) notifies all of its owning SSCPs that a route verification test failed and (2) identifies the subarea that originated the test. The SSCPs in turn pass this information to their respective network operators.

## ***Extended NCP Ownership***

The *extended NCP ownership* capability of Level 3 of ACF allows ownership of any link between network control programs to be exercised by up to eight SSCPs in the network. Thus several SSCPs can activate a given link between network control programs. Information maintained in the programs reflects the current number of SSCPs that own (have activated) the link. Each SSCP may "deactivate" the link when it has no further use for it, without actually causing the link to be deactivated. Only when a Deactivate Link command is received from the last remaining owner does the network control program actually deactivate the link.

Because any link between network control programs can be owned by any SSCP regardless of location in the network, a single SSCP may be assigned ownership of *all* network resources, including such links. Thus, control of a network containing multiple host processors can be vested in a single host processor, referred to as a communication management processor. A multiple-processor configuration arranged in this way is called a communication management configuration. The advantage of such a configuration is that all the network resources can be defined in a single processor—the communication management processor—thus leaving all other processors in the network free to perform only application processing. The application host processors do not require network resource definitions and do not participate in controlling the network. Determining the locations of problems in the network is made easier because all such activity is the responsibility of the network operator at the communication management processor; coordination between operators at widely dispersed locations is unnecessary. (Network management aids such as the Network Communication Control Facility and the Network Problem Determination Application program products can be useful in isolating and correcting network problems.)

#### **Dynamic NCP Dump for ACF/TCAM**

In Level 3 of ACF, an improved ACF/TCAM dump facility increases the usefulness of storage dumps of network control programs by permitting them to be taken dynamically, that is, without stopping execution of the network control program. This dynamic dump facility allows many error conditions to be diagnosed without interference to network operation. Because the network control program need not be stopped each time a dump is required for diagnostic purposes, network availability is improved.

#### **Line Trace with Transmission Group Option**

The capability to define a transmission group comprising multiple SDLC links between two network control programs is accompanied by a capability to trace the links in the group as a logical entity. Upon request by a network operator, a specified transmission group is traced in a manner equivalent to the trace of a single link. The transmission group option traces all path information units over the link(s) in the group just as though the group were a single link.

#### ***Reducing Cross-Domain Resource Definitions***

Level 3 of ACF simplifies the task of specifying a network by removing the requirement for defining every cross-domain resource to each domain that is to receive session-initiation requests from such resources. Cross-domain resources need only be defined in the domain that initiates the requests. However, the system programmer must identify to each domain that will receive cross-domain, session-initiation requests the domain(s) that are authorized to make such requests. Otherwise, the requests will be rejected.

Besides simplifying the task of specifying a network, this capability facilitates making changes in the network configuration. After a station has been added to a given domain by the dynamic reconfiguration facility, by dialing into a 3705, or by takeover by an SSCP, that station can request a session with a host LU in any other domain, provided that the host LU is defined in the domain of the initiator of the session as a cross-domain resource. Defining that station or its logical units to the other domain beforehand is not necessary, so long as any session-authorization processing performed in the other domain will accept the session-initiation request. This capability is optional; the system programmer may use it for some, all, or none of the cross-domain resources in the network.



## Chapter 5. Preinstallation Planning Considerations

A great many factors should be considered when an installation is planning to convert a network from one operational level to another through changes in equipment or programs. The need for careful preinstallation planning increases as the network configuration becomes more complex and as the number of different applications it supports grows. While each installation is unique and no specific preinstallation planning procedure can be prescribed here, some general areas of planning can be identified. These preinstallation planning considerations are mostly posed as questions that the installation manager, or other person responsible for the conversion effort, must be able to answer.

### *Objectives*

Before objectives can be set for the upgraded network, the characteristics of the present network must be considered.

What is the present network configuration? What applications presently use the network? Does the network meet the needs of the applications? If not, in what ways does it not? (Identifying these lacks can help in setting objectives for the upgraded network.)

How does the present network perform? For example, is the average response time experienced by users of the network satisfactory—during periods of average traffic flow in the network? during periods of peak flow? What backup plans are in effect for various kinds of failures?

It is important to document these and any other pertinent characteristics of the present network as a basis for comparison when planning the improved network.

What are the objectives of the improved network—adding new applications? upgrading existing applications, as by improving average response time? adding new types of stations? increasing flexibility of network operation, as by allowing more types of stations to communicate with the same application programs, or providing alternate routes between network control programs? using flow control techniques to forestall data congestion in the network? arranging for further distribution of function into the network to relieve processing loads at the central site(s)? consolidating two or more separate networks to reduce communication line costs? providing parallel links between network control programs to improve path reliability?

Must all of the identified objectives be met at once? If not, consider how the network can be upgraded in steps. Also consider what effect each step will have on existing network operations. Will present users of the network notice any changes, as in procedures for access to the network or in response times? What can be done to minimize the effects on and possible inconvenience to present users?

These and similar questions should be answered early in the preinstallation planning process.

### *Resources*

While objectives are being set for the new network, the resources needed to fulfill those objectives must be identified. Some resources are permanent, such as stations to be added to the network. Others are temporary, such as the programmer time needed to program new applications and the extra computer time that may be needed for testing the upgraded network before it goes into normal operation.

What equipment is needed: at the host processor site(s)? at remote sites? Will timely maintenance service be available for the new equipment? (This question is especially important for remote sites, which may be distant from centers of data processing expertise.)

What programming will be needed to meet the objectives of the upgraded network? Most new and improved functions provided by a new level of ACF/TCAM or ACF/VTAM require complementary support in ACF/NCP/VS, and vice versa. Should the access method(s) be upgraded first? Or should the network control program(s) be upgraded first? Are the program resources compatible? For example, will the functions provided by the network control program be supported by the operating system? by programming subsystems such as CICS/VS?

What service aids and programs (such as the Network Problem Determination Application) are required or desirable?

What communication services are required to implement the upgraded network? Will they be available in all the locations to be connected? Will they be available at the appropriate time?

What personnel resources will be required? What new people hired and trained? What existing people retrained? These questions should be asked and answered for both the network development effort and the continuing operations of the network after it is placed in service.

## *Network Control*

A most important aspect of a complex network is the manner in which it will be controlled. Multiple-domain networks provide the opportunity for distribution of the control function between two or more network control operators.

Will the network be controlled from one site or more than one? At any moment, will the entire network be controlled from one site, or from more than one? If more than one, how will the control responsibility be divided? In case of failure of one point, will the other point be able to assume control of the entire network? How will the multiple control sites coordinate their activities if failure of one part of the network interrupts communication between them?

Backup and recovery procedures are especially important in a complex network. Each possible kind of failure should be anticipated.

What will be the effect on the network of failure of a host processor or access method? of a communications controller or network control program? of a communication line, a modem, a cluster controller, or a terminal? of a cross-domain link? In each case: what problem determination procedures will be used? how can the effect on the network be minimized? What backup resources (such as alternate communication lines or virtual routes) should be available?

What procedures are required by the network control operator(s) and users of the network to operate in backup mode? to return to normal operation? to notify network users of changing to backup mode and reverting to normal operation? These procedures should be documented and made available to the individuals who will be affected.

## *Test Plans*

Preinstallation planning for upgrading of a network should include appropriate testing to make sure not only that new applications and network functions work correctly but also that existing applications and network functions are not impaired. A test plan should be prepared and agreed to by all who may be affected.

What new functions or applications will the upgraded network perform? How should each be tested? What existing functions could be impaired through conflict with the new ones? Should old and new functions be tested at the same time?

Exceptional conditions, as well as normal network operations, should be tested. Consideration should be given to testing the network under peak traffic loads as well as during periods of normal traffic. (The Teleprocessing Network Simulator [TPNS] can be useful in testing as well as in capacity planning.) Backup and recovery functions should be tested by forcing error conditions, as, for example, turning off power on various network components such as controllers and modems and verifying that the network recovers properly from that action.

## *Training*

Some training will be necessary for users and personnel responsible for network operations: terminal operators, computer operators, and network control operators, among others. System programmers and others involved in the development effort may need to learn about new versions of access methods, network control programs, and other programs to be used in the upgraded network. If network control programs are to be modified to meet special needs, the programmers responsible for the activity will need to become intimately familiar with the internal logic of the network control program and knowledgeable about Systems Network Architecture.

As mentioned earlier, network operating procedures, including those for backup and recovery from failure conditions of various kinds, should be documented. Some training of operators and others may be required for them to understand these procedures.

## *Scheduling*

During consideration of all of the factors outlined above, and any others that may apply to a given installation, the question of timing will necessarily arise. Once all of the network requirements and the resources to meet them are identified, a detailed schedule of events should be developed in cooperation with all responsible individuals affected.

The schedule should reflect realistic estimates of the availability of the needed resources, with contingency factors included. Some resources will take longer to put in place than others. Lead times for new equipment and installation of communication services, especially, may be considerable. Also important is a realistic assessment of the personnel resources involved in developing the network improvements. For example, will the needed system programmers be available and have been appropriately trained at points in the schedule when they are required?

When the detailed schedule of events is developed from all of the preceding factors, it should be agreed to by all who will be providing resources and by those responsible persons whose operations will be affected by the network improvement effort. The proper review and approval of the detailed schedule should minimize the problems that could arise due to misunderstandings as to priorities and responsibilities involved in the development process.



## Appendix A. Communication Stations and Systems Supported by ACF Level 3

This appendix lists the communication products supported by the major components of Level 3 of Advanced Communications Function: ACF/TCAM Version 2 Release 3, ACF/VTAM Release 3, and ACF/NCP/VS Release 3. Some of the products listed are not supported by prior levels of ACF, nor by all programming subsystems with which the access methods can communicate. Further, some of the products qualified by footnotes indicating non-support by ACF/VTAM Release 3 are supported by prior versions of ACF/VTAM. For detailed information on communication products supported, consult your IBM representative.

ACF/TCAM, ACF/VTAM, and ACF/NCP/VS support the products listed below when they are connected to a 3705-I or 3705-II communications controller by either non-switched or switched lines, except as noted. Also listed are the communication products supported directly by ACF/VTAM and ACF/TCAM when locally attached to a host processor channel.

### Remote Attachment to Host Processor via 3705-I or 3705-II

The following stations and systems are supported by ACF/NCP/VS in a 3705-I or 3705-II communications controller. (Some of these stations and systems are supported also—or only—as compatible with other stations and systems. See “Compatible Remote Stations” below.)

#### SNA-SDLC Stations and Systems

IBM 3271 Control Unit (Models 11, 12)<sup>1</sup>  
IBM 3274 Control Unit (Model 1C)<sup>1</sup>  
IBM 3275 Display Station (Models 11, 12)<sup>1</sup>  
IBM 3276 Control Unit Display Station (Models 11, 12, 13, 14)<sup>4</sup>  
IBM 3601 Finance Communication System  
IBM 3602 Finance Communication System  
IBM 3614 Consumer Transaction Facility<sup>1</sup>  
IBM 3624 Consumer Transaction Facility<sup>1</sup>  
IBM 3651 Store Controller (Models A50, Q50)<sup>3</sup>  
IBM 3651 Store Controller (Models A60, B60)<sup>3</sup>  
IBM 3661 Store Controller (U.S.A. only)<sup>2, 3</sup>  
IBM 3684 Point of Sale-Control Unit<sup>3</sup>  
IBM 3767 Communication Terminal (Models 1, 2, 3)  
IBM 3771 Communication Terminal (Models 1, 2, 3)  
IBM 3773 Communication Terminal (Models 1, 2, 3, P1, P2, P3)  
IBM 3774 Communication Terminal (Models 1, 2, P1, P2)  
IBM 3775 Communication Terminal (Models 1, P1)  
IBM 3776 Communication Terminal (Models 1, 2, 3, 4)  
IBM 3777 Communication Terminal (Models 1, 3)  
IBM 3791 Communications Controller  
IBM 6670 Information Distributor  
IBM Series/1

<sup>1</sup> Nonswitched lines only

<sup>2</sup> Switched lines only

<sup>3</sup> Not supported by ACF/TCAM, Version 2, Release 3

<sup>4</sup> Not supported by ACF/VTAM, Release 3

## Binary Synchronous (BSC) Stations and Systems

IBM 1131 Central Processing Unit<sup>4</sup>  
IBM 1826 Data Adapter Unit<sup>4</sup>  
IBM 2715 Transmission Control (Model 2)<sup>4</sup>  
IBM 2772 Multipurpose Control Unit<sup>4</sup>  
IBM 2780 Data Transmission Terminal<sup>4</sup>  
IBM 2972 Station Control Unit (Models 8, 11) (U.S.A. only)<sup>1,4</sup>  
IBM 3271 Control Unit (Models 1, 2)<sup>1</sup>  
IBM 3275 Display Station (Models 1, 2)<sup>1</sup>  
IBM 3735 Programmable Buffered Terminal<sup>4</sup>  
IBM 3741 Data Station (Models 2, 4)<sup>4</sup>  
IBM 3747 Data Converter<sup>4</sup>  
IBM 3750 Switching System (World Trade only)<sup>1, 4</sup>  
IBM 5110 Portable Computer<sup>4</sup>  
IBM System/3<sup>4</sup>  
IBM System/360 Model 20<sup>4</sup>  
IBM System/360<sup>4</sup> (Models 25, 30, 40, 50, 65, 67 (in 65 mode), 75, 85, 91, 195)  
IBM System/370 Models 115–168MP<sup>4</sup>

## Start-Stop Stations

IBM 1051 Control Unit<sup>4</sup>  
IBM 2740 Communication Terminal (Model 1)<sup>5</sup>  
IBM 2740 Communication Terminal (Model 2)<sup>1,4</sup>  
IBM 2741 Communication Terminal<sup>5</sup>  
AT&T 83B3 line control type (U.S.A. only)<sup>1, 4</sup>  
Western Union 115A line control type (U.S.A. only)<sup>4</sup>  
CPT-TWX (Models 33, 35) line control type (U.S.A. only)<sup>2, 5</sup>  
World Trade teletypewriter (teleprinter) terminals<sup>1, 6</sup>

## Compatible Remote Stations

The following stations are supported by ACF/NCP/VS in a 3705-I or 3705-II communications controller as compatible with the types of stations indicated in parentheses:

## SNA-SDLC Stations

IBM 3274 Control Unit (Model 1C) (as a 3791)  
IBM 3276 Control Unit Display Station (Models 1, 2, 3, 4) (as a 3791)<sup>4</sup>  
IBM 3276 Control Unit Display Station (Models 11, 12, 13, 14) (as a 3791)  
IBM 3631 Plant Communication Controller (as a 3601 or 3602)  
IBM 3632 Plant Communication Controller (as a 3601 or 3602)  
IBM 3771 Communication Terminal (Models 1, 2, 3) (as a 3767)  
IBM 3773 Communication Terminal (Models 1, 2, 3) (as a 3767)  
IBM 3774 Communication Terminal (Models 1, 2) (as a 3767)  
IBM 3775 Communication Terminal (Models 1, 2) (as a 3767)  
IBM 5937 Industrial Terminal (as a 3271 Model 1 or 2)  
IBM 8130 Processor (as a 3791 or [ACF/VTAM only] 3276 Model 11, 12, 13 or 14)  
IBM 8140 Processor (as a 3791 or [ACF/VTAM only] 3276 Model 11, 12, 13 or 14)

<sup>1</sup> Nonswitched lines only

<sup>2</sup> Switched lines only

<sup>3</sup> Not supported by ACF/TCAM, Version 2, Release 3

<sup>4</sup> Not supported by ACF/VTAM, Release 3

<sup>5</sup> Supported by ACF/VTAM, Release 3, through Network Terminal Option; when station is attached to switched line, dial-in support only is provided

<sup>6</sup> Supported by ACF/VTAM, Release 3, through Network Terminal Option

## Binary Synchronous (BSC) Stations

IBM System/32 (as a 3770)  
IBM System/34 (as a 3770 or 3791, or [ACF/TCAM only] 3767)  
IBM System/38 (as a 3770)  
IBM 3274 Control Unit (Model 1C) (as a 3271 Model 1 or 2)  
IBM 3276 Control Unit Display Station (Models 1, 2, 3, 4) (as a 3271 Model 1 or 2)  
IBM 3770 Data Communication System terminals (as a 2772)<sup>4</sup>  
IBM 3780 Data Communication Terminal (as a 2772)<sup>4</sup>  
IBM 5275 Direct Numerical Control Station (as a 3275 Model 1 or 2)<sup>2, 4</sup>  
IBM 5937 Industrial Terminal (as a 3271 Model 1 or 2)  
IBM 6670 Information Distributor (as a 2772)<sup>4</sup>  
IBM 8130 Processor (as a 3271 Model 1 or 2)<sup>5</sup>  
IBM 8140 Processor (as a 3271 Model 1 or 2)<sup>5</sup>  
IBM System/7 Processor Station (as a System/3)<sup>4</sup>  
IBM System/32 Batch Work Station (as a System/3)<sup>4</sup>  
IBM System/34 (as a System/3)<sup>4</sup>  
IBM Series/1 (as a System/3)<sup>4</sup>

## Start-Stop Stations

IBM 3767 Communication Terminal (Models 1, 2) (as a 2740 Model 1 or 2 or a 2741)<sup>4</sup>  
IBM 3767 Communication Terminal (Model 3) (as a 2740 Model 2)<sup>4</sup>  
IBM 5100 Portable Computer (as a 2741)<sup>4</sup>  
IBM 5110 Portable Computer (as a 2741)<sup>4</sup>  
IBM Communicating Magnetic Card Selectric ® Typewriter (as a 2741)<sup>4</sup>  
IBM System/7 Processor Station (as a 2740 Model 1)<sup>4</sup>

## Equivalent Remote Stations

Stations that are functionally equivalent to those listed above may also operate satisfactorily with ACF/NCP/VS in combination with ACF/TCAM or ACF/VTAM. The customer is responsible for establishing equivalency.

## Local Attachment to Host Processor via Data Channel

The following stations and systems are supported directly by ACF/TCAM and/or ACF/VTAM, as noted, when attached to a host processor channel. (Some of these stations and systems are supported also—or only—as compatible with other stations and systems. See “Compatible Local Stations” below.)

## SNA Stations and Systems

IBM 3274 Control Unit (Model 1A)  
IBM 3791 Communications Controller <sup>8</sup>

<sup>1</sup> Nonswitched lines only

<sup>2</sup> Switched lines only

<sup>3</sup> Not supported by ACF/TCAM, Version 2, Release 3

<sup>4</sup> Not supported by ACF/VTAM, Release 3

<sup>5</sup> Supported by ACF/VTAM, Release 3, through Network Terminal Option; when station is attached to switched line, dial-in support only is provided

<sup>6</sup> Supported by ACF/VTAM, Release 3, through Network Terminal Option

<sup>7</sup> Not supported by ACF/VTAM

<sup>8</sup> ACF/TCAM support requires configuration support 9165 or 9169.

## **Non-SNA Stations and Systems**

IBM 2260 Display Station <sup>7</sup>  
IBM 2715 Transmission Control Unit (Model 1)<sup>4</sup>  
IBM 3272 Control Unit (Models 1, 2)  
IBM 3274 Control Unit (Models 1A, 1B, 1D)<sup>4</sup>  
IBM 3791 Communications Controller  
IBM 7770 Audio Response Unit (Model 3)<sup>4</sup>

## ***Compatible Local Stations***

The following stations are supported as compatible with the types of stations indicated in parentheses when attached to a host processor channel.

## **SNA Station**

IBM 3274 Control Unit (Model 1A) (as a 3791)

## **Non-SNA Stations**

IBM 3791 Communications Controller (as a 3271 Model 1 or 2)<sup>4</sup>  
IBM 3274 Control Unit (Model 1B or 1D) (as a 3272 Model 1 or 2)

## ***Equivalent Local Stations***

Stations that are functionally equivalent to those listed above may also operate satisfactorily with ACF/TCAM and/or ACF/VTAM when attached to a host processor channel. The customer is responsible for establishing equivalency.

<sup>1</sup> Nonswitched lines only

<sup>2</sup> Switched lines only

<sup>3</sup> Not supported by ACF/TCAM, Version 2, Release 3

<sup>4</sup> Not supported by ACF/VTAM, Release 3

<sup>5</sup> Supported by ACF/VTAM, Release 3, through Network Terminal Option; when station is attached to switched line, dial-in support only is provided

<sup>6</sup> Supported by ACF/VTAM, Release 3, through Network Terminal Option

<sup>7</sup> Not supported by ACF/VTAM

<sup>8</sup> ACF/TCAM support requires configuration support 9165 or 9169.

## Appendix B. Glossary of Terms and Abbreviations

This glossary contains definitions reproduced from the *American National Dictionary for Information Processing*, copyright 1977 by the Computer and Business Equipment Manufacturers Association, copies of which may be purchased from the American National Standards Institute at 1430 Broadway, New York, New York 10018.

ANSI definitions are identified by an asterisk.

**access method:** A technique for moving data between main storage and input/output devices.

**ACF:** Advanced Communications Function

**ACF/NCP/VS:** Advanced Communications Function/Network Control Program/Virtual Storage. *See also network control program.*

**ACF/TCAM:** *Advanced Communications Function for the Telecommunications Access Method.*

**ACF/VTAM:** *Advanced Communications Function for the Virtual Telecommunications Access Method*

**adjacent domains:** Domains sharing a common network control program (ACF/NCP/VS) or two domains connected by a cross-domain link. *See also domain.*

**adjacent subareas:** Two subareas connected by (1) a subchannel, (2) a local-local link, or a local-remote link. *See also subarea.*

**Advanced Communications Function (ACF):** A group of IBM program products (principally ACF/TCAM, ACF/VTAM, and ACF/NCP/VS, that use the concepts of Systems Network Architecture (SNA), including distribution of function and resource sharing. The Multisystem Networking Facility of ACF/TCAM, ACF/VTAM, and ACF/NCP/VS allows the interconnection of two or more domains into one consolidated and coordinated multiple-domain network.

**application program:** (1) A program written for or by a user that applies to the user's work. (2) A program used to connect and communicate with terminals in a network, enabling users to perform application-oriented activities.

**asynchronous:** Without regular time relationship; unexpected or unpredictable with respect to the execution of a program's instructions.

**basic information unit (BIU):** In SNA, a unit of data and control information that is passed between connection point managers. It consists of a request-response header (RH), followed by a request-response unit (RU).

**binary synchronous communication (BSC):** Communication using binary synchronous line discipline. *See binary synchronous transmissions.*

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

**bind image:** In SNA, a string of parameters in a Bind Session request that specifies the allowable protocols for an LU-LU session.

**bps:** Bits per second.

**BSC:** Binary synchronous communication.

**buffer:** (1) \*A routine or storage used to compensate for a difference in rate of flow, or time of occurrence of events, when transmitting data from one device to another. (2) An area of storage that is temporarily reserved for use in performing an input/output operation, into which data is read or from which data is written.

**chain:** For logical units, one or more related units of data; each unit is identified as the first, middle, last, or only element of a chain. Each physical transmission is a chain.

**channel:** A device that connects the host processor and main storage with the I/O control units.

**channel adapter:** A communications-controller hardware unit used to attach the controller to a System/370 channel.

**cluster controller:** A device that can control the input/output operations of more than one device. *See also communications controller.*

**communication common carrier:** In the USA, a government-regulated private company that furnishes the general public with telecommunication service facilities; for example, a telephone or telegraph company.

**communication line:** A physical connection, such as a wire or a telephone circuit, between communications controllers or between a communications controller and a station. Synonym for line. *See also data link.*

**communications controller:** A type of communication control unit whose operations are controlled by a program stored and executed in the unit. It manages the details of line control and routing of data through a network. It can route data to the host processor, or it can route data to or from a cluster controller or terminal. Examples are the IBM 3704 and 3705 Communications Controllers.

**cross-domain communication:** In a multiple-domain network, communication between domains; synonymous with *networking*.

**cross-domain LU:** A logical unit (LU) located in another domain.

**cross-domain session:** A session between logical units (LUs) in different domains; a cross-domain LU-LU session. Contrast with *same-domain session*.

**cryptographic:** Pertaining to the transformation of data to conceal its meaning.

**data link:** A generic term for any physical facility used to carry data from one resource to another; examples are channels, communication lines, and communication loops.

**data link control:** (1) The noninformation exchanges that set up, control, check, and terminate the information exchanges between two stations on a data link. (2) In SNA, a part of the transmission subsystem layer. It initiates, controls, checks, and terminates the data transfer over a data link between two nodes. See also *path control*.

**distributed function:** The use of programmable stations and controller to perform operations that are otherwise done by the host processor, such as network control, processing, and error-recovery operations.

**domain:** The collection of network resources controlled by one system services control point (SSCP). Synonymous with *single-domain network*.

**DOS/VS:** Disk Operating System/Virtual Storage.

**echo test:** A diagnostic aid that permits an SNA station operator to ensure that the path to the owning host is functional.

**emulation mode:** The function of a network control program that enables it to emulate a transmission control unit. Contrast with *network control mode*.

**emulation program (EP):** A control program that allows a channel-attached IBM 3704 or 3705 Communications Controller to emulate the function of an IBM 2701 Data Adapter Unit, an IBM 2702 Transmission Control, and/or an IBM 2703 Transmission Control. Contrast with *network control program*.

**end user:** In SNA, the ultimate source or destination of information flowing through the network. It may be an application program, an operator, or a data medium (such as cards or tapes).

**EP:** Emulation program.

**explicit route:** A sequence of physical network elements (such as links and communications controllers) over which two subareas communicate. See also *subarea*. Contrast with *virtual route*.

**extended NCP interconnection:** The capability, available with ACF/NCP/VS, Release 3, that allows the same functions to be performed by both channel-loaded and link-loaded network control programs (ACF/NCP/VS, Release 3). This capability allows any controller to be connected to any other controller in the network.

**host access method:** The access method, either ACF/TCAM or ACF/VTAM, that controls data communication with a domain.

**host LU:** An SNA logical unit (LU) in a host processor.

**host node:** Synonym for *host processor*.

**host processor:** The System/370 with its operating system, access methods, and application programs; the host processor oversees the entire domain. The system services control point (SSCP) is located in the host processor. Synonymous with *host node*.

**I/O:** Input/output.

**K:** Thousand (1,024, when referring to bytes of storage).

**link:** In SNA, the physical connections and the connection protocols (1) between network control programs and (2) between network control programs, cluster controllers, and terminals.

**load module:** A program in a format suitable for loading into storage for execution.

**local station:** A station whose control unit is connected directly to a computer data channel by a local cable. Also referred to as a channel-attached station. Contrast with *remote station*.

**logical unit (LU):** The means by which an end user accesses the network in order to communicate with another end user. It is also the means by which an end user accesses the services provided by the system services control point (SSCP). See also *host LU*, *out-board LU*, *physical unit*, *system services control point*.

**LU:** Logical unit.

**LU-LU session:** In SNA, a session between two logical units in the network. It provides communication between two end users, each associated with one of the logical units. See also *cross-domain session* and *same-domain session*.

**message:** A combination of characters and symbols transmitted from one point to another in a network.

**message handler:** A sequence of user-specified macro instructions that invoke routines that examine and process control information in message headers and perform functions necessary to prepare messages for forwarding to their destinations.

**message header:** The leading part of a message that contains information such as the source or destination code of the message, the message priority, and the type of message.

**multiple-domain network:** A network with more than one system services control point (SSCP). Contrast with *single-domain network*.

**multipoint line:** A line or circuit interconnecting several stations. Contrast with *point-to-point line*.

**Multisystem Networking Facility:** An optional feature of ACF/TCAM and ACF/VTAM that permits these access methods, together with ACF/NCP/VS, to control a multiple-domain network.

**network:** (1) The assembly of equipment through which connections are made between installations. (2) A configuration in which two or more station installations are connected. See also *domain*, *multiple-domain network*, and *single-domain network*.

**network addressable unit:** In SNA, a logical unit, a physical unit, or a system services control point. It is the origin or the destination of information transmitted in the transmission subsystem layer. Each network addressable unit has a network address that represents it to the transmission subsystem layer.

**network control mode:** The functions of a network control program that enable it to direct a communications controller to perform activities such as polling, device addressing, dialing, and answering. Contrast with *emulation mode*.

**network control program:** A control program for the IBM 3704 and 3705 Communications Controllers generated by the user from a library of IBM-supplied modules. ACF/NCP/VS operates only in the IBM 3705 Communications Controller.

**networking:** In a multiple-domain, network, communication between domains.

**node:** A junction point in a network represented by a physical unit; an addressable point in a network. The host processor, communications controllers, cluster controllers, and some SNA stations are nodes.

**nonswitched line:** A connection between a remote station and a communications controller that does not have to be established by dialing. See also *point-to-point line* and *multipoint line*.

**OS/VS:** Operating System/Virtual Storage.

**outboard LU:** An SNA logical unit located outside a host processor in an SNA cluster controller or terminal. Contrast with *host LU*.

**pacing:** In SNA, a technique by which a receiving LU controls the rate of transmission of a sending LU to prevent overrun.

**partitioned emulation programming (PEP) extension:** A function of a network control program that enables a communications controller to operate some communication lines in network control mode while simultaneously operating others in emulation mode.

**PEP:** Partitioned emulation programming.

**physical transmission:** (1) For non-SNA devices, the amount of data entered on a line during an entire transmission sequence, from the first byte of data to the end-of-transmission character. (2) For logical units, a physical transmission is a chain.

**physical unit (PU):** In SNA, one of three types of network addressable units; a PU is associated with each node whose existence has been defined to the system services control point (SSCP). A physical unit controls the resources local to its associated node. The SSCP establishes a session with the physical unit as part of the bring-up process.

**PIU:** Path information unit.

**point-to-point line:** A line that connects a remote station to a host processor; it may be either switched or nonswitched. Contrast with *multipoint line*.

**polling:** A technique by which a device is periodically interrogated to determine whether it needs servicing.

**primary LU:** A logical unit (LU) that issues a Bind Session request to establish an LU-LU session; the logical unit that controls an LU-LU session. Contrast with *secondary LU*.

**public network:** A network established and operated by communication common carriers or telecommunication Administrations for the specific purpose of providing circuit-switched, packet-switched, and leased-circuit services to the public. Contrast with *user application network*.

**remote station:** A station that is connected to a computer data channel through a communication control unit. Also referred to as a link-attached station. Contrast with *local station*.

**request/response header (RH):** In SNA, a control field, attached to a request/response unit (RU), that specifies the type of RU being transmitted—request or response—and contains control information associated with that RU. It is used by sending and receiving connection point managers to coordinate data traffic between network addressable units. See also *request/response unit* and *connection point manager*.

**request/response unit (RU):** In SNA, the basic unit of information entering and exiting the transmission subsystem layer. It may contain data, acknowledgement of data, commands that control the flow of data through the network, or responses to commands.

**response:** In SNA, synonym for *request/response unit*.

**RH:** Request/response header.

**route:** In an SNA network, a series of interconnected SDLC links and SNA nodes over which messages flow from one subarea to another subarea.

**RU:** Request/response header.

**same-domain session:** An LU-LU session between logical units (LUs) in the same domain. Contrast with *cross-domain session*.

**SCP:** Systems control program.

**SDLC:** Synchronous data link control.

**secondary LU:** In an LU-LU session, the partner that receives the Bind Session request. Contrast with *primary logical unit*.

**single-domain network:** A network with one system services control point (SSCP). Contrast with *multiple-domain network*.

**SNA:** Systems network architecture.

**SNA session:** A logical connection established between two network addressable units (NAU) to allow them to communicate. The session is uniquely identified by a pair of network addresses identifying the origin and destination NAUs of any transmissions exchanged during the session. See also *LU-LU session*, *SSCP-LU session*, *SSCP-PU session*.

**SSCP:** System services control point.

**SSCP backup:** The changing of domain boundaries so that network resources move from one domain to another.

**SSCP-LU session:** An SNA session between the system services control point (SSCP) and a logical unit (LU). It is used to support logical-unit-related control and use of the communication system. Each logical unit in the network must participate in a session with the SSCP that provides services for that logical unit.

**SSCP-PU session:** An SNA session between the system services control point (SSCP) and a physical unit (PU) that is used to control the physical configuration of a network and to control an individual node.

**start-stop transmission:** Asynchronous transmission whereby a group of bits is preceded by a start bit that prepares the receiving mechanism for the reception and registration of a character, and is followed by at least one stop bit that enables the receiving mechanism to come to an idle condition pending the reception of the next character. Contrast with *binary synchronous transmission* and *synchronous data link control*.

**station:** A point in a data communication network at which data can enter or leave. As used in this publication, a terminal, a cluster controller, or a communications controller.

**subarea:** In SNA: (1) A subfield in the network address. (2) The group of network addressable units sharing a common subarea address. The network address space is partitioned into subareas and each subarea is further divided into elements. Subareas are the basic units of routing in SNA.

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

**synchronous data link control (SDLC):** A discipline for managing synchronous, transparent, serial-by-bit information transfer over a communication channel. Transmission exchanges may be duplex or half-duplex over switched or nonswitched data links. The communication channel configuration may be point-to-point, multipoint, or loop. Contrast with *binary synchronous transmission* and *start-stop transmission*.

**system services control point (SSCP):** In SNA, a network addressable unit that provides configuration, maintenance, and session services via a set of command processors—network services—supporting physical units and logical unit. The SSCP must be in session with each logical unit and each physical unit for which it provides these services.

**systems network architecture (SNA):** The total description of the logical structure, formats, protocols, and operational sequences for transmitting information units through a communication system.

**TH:** Transmission header.

**transmission header (TH):** In SNA, a control field attached to a basic information unit (BIU) or to a BIU segment, and used by path control. It is created by the sending path control component and interpreted by the receiving path control component. See also *path information unit*.

**TWX:** Teletypewriter Exchange.

**user-application network:** A configuration of data processing products, such as processors, controllers, and terminals, established and operated by users for the purpose of data processing or information exchange, which may use services offered by common carriers or telecommunication Administrations. Contrast with *public network*.

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## Introduction to Advanced Communications Function

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This Technical Newsletter provides replacement pages for the subject publication. These pages remain in effect for subsequent revisions of the publication unless specifically altered. The pages to be replaced are:

Title page, Edition Notice  
iii--vi  
1-3, 1-4  
2-19, 2-20  
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4-15, 4-16  
A-1--A-4

A change to the text is indicated by a vertical line to the left of the change.

### Summary of Changes

This Technical Newsletter contains information on support of the Network Terminal Option program product by ACF/TCAM, Version 2, Release 3, and adds references to (1) Release 2.1 of ACF/NCP/VS, (2) ACF support of the Network Job Entry facility for Release 3 of the JES2 program product, (3) CICS/VS support of the ACF/VTAM parallel-session capability, and (4) use of ACF/VTAME in a SNA-based network. This Newsletter also updates Appendix A to list additional communication products supported by Level 3 of ACF and contains minor corrections and clarifications.

*Note:* Please file this cover letter at the back of the publication to provide a record of changes.



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**Program Product**

**Introduction to  
Advanced Communications  
Function**



## Second Edition (May 1979)

This is a major revision of, and makes obsolete, GC30-3033-0. This edition applies to:

- ACF/TCAM, Version 2, Releases 1, 2, and 3 (Program No. 5735-RC3 [OS/VS1 and OS/VS2 (MVS)])
- ACF/VTAM, Releases 2 and 3 (Program Nos. 5735-RC2 [OS/VS1 and OS/VS2 (MVS)], 5746-RC3 [DOS/VS1])
- ACF/NCP/VS, Releases 2, 2.1, and 3 (Program No. 5735-XX1)

and to all subsequent versions and releases unless otherwise indicated in new editions or Technical Newsletters.

The Summary of Changes page describes the changes in this edition. Much of the material in the previous edition has been revised and reorganized and the present edition should be reviewed in its entirety.

Changes are periodically made to the information herein; before using this publication in connection with the operation of IBM systems, refer to *IBM System/370 Bibliography*, GC20-0001, for the editions that are applicable and current.

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## Preface

This publication introduces the types of System/370-based data communication networks<sup>1</sup> whose operation is managed by programming components of Advanced Communications Function: ACF/TCAM (Advanced Communications Function for Telecommunications Access Method), ACF/VTAM (Advanced Communications Function for Virtual Telecommunications Access Method), and ACF/NCP/VS (Advanced Communications Function for Network Control Program/Virtual Storage). This publication is directed primarily to data processing managers and network designers who may want to install or upgrade a network or consolidate existing networks.

ACF/TCAM, ACF/VTAM, and ACF/NCP/VS are licensed program product versions of TCAM, VTAM, and NCP/VS, which are system control programs (SCP). The program product versions contain significant enhancements to the SCP versions.

The general term *SNA-based network* as used in this publication represents a network that is managed and controlled by programming components designed in accordance with the IBM Systems Network Architecture (SNA). SNA-based networks may include stations that are not designed in accordance with SNA as well as those that are so designed.

This publication is organized into five chapters and two appendixes:

- Chapter 1 introduces Advanced Communications Function and its purpose, and introduces the concept of network domains.
- Chapters 2 and 3 describe networks as supported by ACF/TCAM, Version 2, Release 2; ACF/VTAM, Release 2, and ACF/NCP/VS, Releases 2 and 2.1.<sup>2</sup> These programs are collectively referred to in this publication as *Level 2* of ACF.

Chapter 2 describes the components and characteristics of a single-domain network that uses ACF/TCAM or ACF/VTAM as the access method and ACF/NCP/VS to control data flow to and from remote stations in the network.

Chapter 3 describes how two or more networks can be interconnected to form a multiple-domain network in which the network resources in one domain can be shared by other domains.

- Chapter 4 introduces the added capabilities that will be available in ACF/TCAM, Version 2, Release 3; ACF/VTAM, Release 3; and ACF/NCP/VS, Release 3. These programs are collectively referred to in this publication as *Level 3* of ACF. These capabilities can improve the efficiency and reliability of SNA-based networks and can make them easier to install and use.
- Chapter 5 contains preinstallation planning information in the form of questions to be answered by the installation manager (or other individual responsible for planning the development of an SNA-based network) during the preinstallation phase of the project.
- Appendix A lists the communication products supported by *Level 3* of ACF.
- Appendix B is a glossary of terms and abbreviations.

**Note:** References in this publication to System/370 processors should be understood to apply also to 3031, 3032, 3033, 4331, and 4341 processors used as host processors in a network.

<sup>1</sup>The term *network* has at least two meanings. A *public network* is a network established and operated by common carriers or telecommunication Administrations for the specific purpose of providing circuit-switched, packet-switched, and leased-circuit services to the public. A *user application network* is a configuration of data processing products, such as processors, controllers, and terminals, established and operated by users for the purpose of data processing or information exchange, which may use transport services offered by common carriers or telecommunication Administrations. *Network* as used in this publication refers to a user application network.

<sup>2</sup>In this publication, references to Release 2 of ACF/NCP/VS should be understood to apply also to Release 2.1, which performs the same functions as Release 2 and has added capabilities that are described in *ACF/NCP/VS (Network Control Program and System Support Programs) General Information, GC30-3058-1*, as amended by Technical Newsletter GN30-3131.

Both ACF/VTAM and ACF/TCAM accommodate a large variety of network resources (terminals, cluster controllers, communications controllers, and processors) in networks of various sizes and degrees of complexity. This publication does not compare the facilities provided by the access methods; rather, it stresses the capabilities that these access methods, in combination with ACF/NCP/VS, bring to data networks. The choice of which access method to use depends on the requirements of the applications for which the network is to be used. Some networks may require both access methods. See the publications *ACF/TCAM General Information: Introduction*, GC30-3057, and *ACF/VTAM General Information: Introduction*, GC27-0462, for details of these access methods.

Prerequisite to use of this publication is a general knowledge of data communication and the concepts of Systems Network Architecture (SNA). Information on these subjects can be found in the publications listed under "Prerequisite Publications."

**Note:** In this publication, long numbers are represented in metric style. A space is used, instead of a comma, to separate groups of three digits.

### Prerequisite Publications

*Systems Network Architecture General Information*, GA27-3102  
*Introduction to Data Communication Systems*, SR20-4461

### Related Reading

*ACF/VTAM General Information: Introduction*, GC27-0462  
*ACF/TCAM General Information: Concepts*, GC27-0463  
*ACF/TCAM General Information: Introduction*, GC30-3057  
*ACF/TCAM General Information: Functional Description*, GC30-3131  
*ACF/NCP/VS (Network Control Program and System Support Programs) General Information*, GC30-3058  
*Network Operation Support Program General Information*, GC38-0251  
*Network Communications Control Facility General Information*, GC27-0429  
*Network Problem Determination Application General Information*, GC34-2010  
*Programmed Cryptographic Facility General Information*, GC28-0942

### Summary of Changes

In this second edition, Chapters 1, 2, and 3 correspond to the Introduction, Part 1, and Part 2 of the first edition. These chapters now include the single-domain and multiple-domain facilities afforded by ACF/TCAM, Version 2, Releases 1 and 2; ACF/VTAM, Release 2; and ACF/NCP/VS, Release 2.

Chapter 4 contains entirely new material describing the significant new capabilities and functions of ACF/TCAM, Version 2, Release 3; ACF/VTAM, Release 3; and ACF/NCP/VS, Release 3. These versions and releases, collectively referred to as *Level 3* of Advanced Communications Function, can improve the reliability, availability, and usability of SNA-based networks.

Chapter 5 is a new chapter that suggests some preinstallation planning considerations for users intending to install or upgrade a SNA-based network.

Appendix A now lists the communication products supported by Level 3 of ACF; Appendix B contains a glossary of terms and abbreviations. The former Appendix B, containing information on the Network Operation Support Program, is deleted.

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ACF/TCAM and ACF/VTAM can support a multiple-processor network, referred to as a *multiple-domain* network, in addition to supporting single-domain networks. A multiple-domain network allows application programs and stations in one domain to communicate with application programs in other domains by means of cross-domain connections. A domain consists of all of the resources, such as terminals and communication lines, that are controlled by an access method in a single host processor. Each domain in a multiple-domain network must contain either ACF/VTAM or ACF/TCAM as the access method that controls the domain. A multiple-domain network allows network resources to be shared among two or more interconnected domains—a concept known as *networking*. Networking requires a feature called Multisystem Networking Facility (MSNF), available for both ACF/TCAM and ACF/VTAM. Multiple-domain networks and networking are described in Chapter 3.

Both ACF/VTAM and ACF/TCAM use the facilities of ACF/NCP/VS (executed in an IBM 3705 Communications Controller) to communicate with remote stations in *network control mode*. When operating lines and stations in this mode, ACF/NCP/VS is performing for the access method those network control services for which the ACF/NCP/VS and the communications controller are principally designed.

ACF/TCAM (but not ACF/VTAM) can also use the ACF/NCP/VS with the partitioned emulation programming extension (an option within ACF/NCP/VS) to control lines and stations in *emulation mode*. When operating lines and stations in emulation mode, ACF/NCP/VS emulates the functions of an IBM 2701 Data Adapter Unit or a 2702 or 2703 Transmission Control, or a combination of these units. The publication *ACF/NCP/VS (Network Control Program and System Support Programs) General Information*, GC30-3058, contains more information on the use of emulation mode.

The IBM facilities for Advanced Communications Function accommodate both single-domain and multiple-domain networks. Five separate facilities provide discrete functional capabilities:

- ACF/VTAM
- ACF/VTAM Multisystem Networking Facility (an optional feature)
- ACF/TCAM
- ACF/TCAM Multisystem Networking Facility (an optional feature)
- ACF/NCP/VS

ACF/TCAM and ACF/VTAM also provide support for the Cryptographic program product for users whose application requirements include the need for assuring the security of data flowing through a network. The support is standard in ACF/TCAM and separately orderable, as the Encrypt/Decrypt feature, in ACF/VTAM. The access method support, in combination with the program product, allows users to establish, control, and terminate access to stations and application programs with cryptographic sessions in which data requiring high security is enciphered when entering the network and deciphered when leaving the network. Information on the access method support may be found in *ACF/VTAM General Information: Concepts*, GC27-0463, and *ACF/TCAM General Information: Functional Description*, GC30-3131. Information on the program product may be found in *Programmed Cryptographic Facility General Information*, GC28-0942.

Because this publication describes the network configurations that are possible with ACF/TCAM, ACF/VTAM, and ACF/NCP/VS, the host processor for the single-domain networks is assumed to contain either ACF/TCAM or ACF/VTAM. For the multiple-domain networks, each host processor must contain either ACF/TCAM or ACF/VTAM and the Multisystem Networking Facility for ACF/TCAM or ACF/VTAM, as appropriate.

The communications controllers must contain ACF/NCP/VS. The program requirements in ACF/NCP/VS are independent of whether ACF/TCAM or ACF/VTAM is to be used in the host processor, or whether ACF/NCP/VS is to be used in a single-domain or a multiple-domain network.

### ***Host Processor Requirements***

ACF/VTAM and ACF/TCAM are executed in one of the following processing units:

- Under OS/VS1: System/370, 3031, 3032, 3033, 4331, 4341 (any model that supports OS/VS1)
- Under OS/VS2: System/370, 3031, 3032, 3033 (any model that supports OS/VS2 MVS)
- Under DOS/VS or DOS/VSE (ACF/VTAM only): System/370, 3031 (any model that supports DOS/VS or DOS/VSE)

The processing units must have the Compare and Swap and the Compare Double and Swap instructions in their instruction sets.

### ***Communications Controller Requirements***

ACF/NCP/VS can be executed in either the IBM 3705-I or 3705-II Communications Controllers. However, certain network configurations and capabilities described in this publication are dependent on hardware options available only in the 3705-II controller. The terms *3705 communications controller*, *3705*, and *communications controller* are used to mean either the 3705-I or 3705-II.

### ***Stations Supported***

Advanced Communications Function accommodates two categories of stations: *SNA stations* and *non-SNA stations*. SNA stations can perform functions defined by Systems Network Architecture (SNA). When attached to a network connected to a 3705 communications controller, SNA stations use the SDLC (synchronous data link control) line discipline. Some types of SNA stations can be directly attached to a host processor channel and directly controlled by ACF/TCAM or ACF/VTAM.

Non-SNA stations include those using the start-stop and binary synchronous (BSC) line control disciplines as well as some stations, such as the IBM 3270 Information Display System, that can be directly attached to a host processor and directly controlled by ACF/TCAM or ACF/VTAM. SNA and non-SNA stations are described under "Systems Network Architecture" in Chapter 2.

Appendix A lists the types of stations and systems that can be remotely attached (via links) and locally attached (via host processor channel) to a network controlled by Advanced Communications Function.

### ***Network Terminal Option***

The Network Terminal Option program product, executed in the 3705 communications controller with the network control program, allows ACF/TCAM, Version 2, Release 3, and ACF/VTAM, Release 2 and Release 3, to support the following non-SNA stations as SNA logical units:

- IBM 2740 Model 1 Communication Terminal (nonswitched and switched lines)
- IBM 2741 Communication Terminal (nonswitched and switched lines)
- Western Union Teletypewriter Exchange Service (TWX) Model 33/35 terminals (switched lines only)
- World Trade teletypewriter terminals (nonswitched lines only)

ACF/VTAM supports these stations only through the Network Terminal Option; ACF/TCAM can also support them as start-stop devices.

For information on the Network Terminal Option, see *Network Terminal Option General Information*, GC38-0297.

*Duplex Operation over Wideband Links:* ACF/NCP/VS allows duplex operation on SDLC links at data rates up to 230 400 bits per second.

*Remote Attachment of 3705-II Communications Controller:* The 3705-II communications controller can be remotely attached to a local 3705 communications controller by an SDLC link. ACF/NCP/VS in the local controller can communicate with a network control program in the remote controller at line speeds up to 57 600 bits per second.

*Local-Local Links between Communications Controllers:* ACF/NCP/VS can control an SDLC link between two local communications controllers in the same domain or in adjacent domains.

*Multiple Channel Attachment Capability:* ACF/NCP/VS supports the concurrent attachment of a single 3705-I communications controller to two data channels (on the same or separate host processors) and a single 3705-II communications controller to two, three, or four channels (on the same or separate host processors). This capability allows (but does not require) a single 3705 and its attached network resources to be partitioned into separate, independent networks. The 3705 and the SDLC links can thus be shared by multiple host processors or multiple access methods in the same host processor. Resources of the network can be moved from one domain to another under operator control.

*Serviceability:* ACF/NCP/VS can perform line traces on up to eight communication lines concurrently. Also, either a local-local or a local-remote link, or a backup link for a local-local or local-remote link, can be tested by an echo test while normal data traffic is flowing on the link not being tested. In addition, ACF/NCP/VS permits channel traces to be turned on and off dynamically from the control panel of the 3705 and also permits the contents of 1 byte of storage to be altered dynamically from the control panel.

*Dynamic Reconfiguration:* By entering commands at a network console, a network operator can dynamically reconfigure the network to add or delete SNA stations on non-switched SDLC links controlled by ACF/NCP/VS. The network control program need not be modified, regenerated, and reloaded into the communications controller. However, a pool of dummy logical units must have been predefined in the network control program in order to add LUs to the network. Dynamic reconfiguration is only a temporary measure to avoid disrupting network operation to modify the network control program. At a convenient time, as when network operation is suspended at the end of the day, the network control program should be updated to reflect any new stations and logical units added by dynamic reconfiguration that are to remain in the network permanently.

*Enhanced SDLC Data Link Testing:* Individual stations on an SDLC link can be tested without interfering with sessions involving other stations on the link. When a station comprises a cluster control unit and its attached devices, the control unit is dedicated to the test and its attached devices must be deactivated.

*Intensive Mode Error Recording:* A network operator can dynamically invoke and terminate recording of information about temporary errors occurring on an SDLC link. This capability permits a user to collect additional information on link errors beyond what is collected for permanent errors. This detailed information may preclude the need for more specific testing of a link to recreate an error situation.

*Dynamic Display of ACF/NCP/VS Storage:* A network operator can display any contiguous 256 bytes of ACF/NCP/VS storage without disrupting normal ACF/NCP/VS operation. The specified storage area is displayed in hexadecimal form on a network operator console. This dynamic display of ACF/NCP/VS storage can be useful in evaluating the status of the network and in determining problems.

*Support for Network Communications Control Facility:* ACF/NCP/VS supports the enhanced problem determination and network operation facilities offered by the Network Communications Control Facility (NCCF) program product and a related program product, Network Problem Determination Application (NPDA). Information on these program products may be found in the related General Information publications, listed in the Preface.

*Support for Network Terminal Option:* ACF/NCP/VS supports the Network Terminal Option program product by allowing inclusion in the ACF/NCP/VS of IBM-provided code that extends record mode operations to IBM 2741, IBM 2740 Model 1, Western Union TWX (Model 33/35), and World Trade Teletypewriter terminals. The support allows these stations to participate in multiple-domain as well as single-domain network operations.

*Inclusion of User Routines and Network Addressable Units:* ACF/NCP/VS allows user-written routines to be included in an ACF/NCP/VS for execution during initialization of the ACF/NCP/VS. ACF/NCP/VS also allows user-written network addressable units (NAUs) to be included and executed during ACF/NCP/VS operation. These routines may be used to add programmed SNA resources, to support non-SNA devices through user-written code, and/or to add line control protocols not provided by IBM in ACF/NCP/VS but compatible with the Type 2 or Type 3 communication scanners of the 3705 communications controller. (Possible future releases of ACF/NCP/VS may require changes to the user-written code.)

specify a particular class of service on the request to initiate the session. (If none is specified, a default class of service is assigned to the session.) The class of service remains assigned until the session ends. The SSCP resolves the class-of-service name to a list of virtual routes, from which one is selected at session initiation.

The access method and the network control programs activate and deactivate virtual routes as needed. They also activate explicit routes occupied by the virtual routes. Network operators do not activate or deactivate routes of either kind, but they do activate and deactivate the physical network elements that form explicit routes.

Operators are informed if an explicit route fails. Besides identifying the failed route, the notification identifies the subarea that detected the failure and the next subarea beyond the detecting subarea along the inoperative route. This notification thus pinpoints the location of the failure so that corrective action can be taken.

If none of the virtual routes on the list of virtual routes is available, a request to establish an LU-LU session is rejected. The LU must make another attempt to establish the session. ACF/TCAM provides a virtual-route-availability monitoring function that allows the host LU to be notified automatically when a virtual route contained in the requested class of service becomes available. When the LU is notified, it automatically retries the session-initiation request.

### ***Alternate Routing in the Event that a Virtual Route is Lost***

An operational virtual route may be lost because one or more of the physical elements in the explicit route to which it is assigned failed or was deactivated. In that event, the access methods and network control programs notify all logical units participating in LU-LU sessions using the route and all SSCPs involved in the SSCP-SSCP, SSCP-PU, and SSCP-LU sessions, that the LU-LU sessions have been terminated. (The topic "Session Outage Notification" later in this chapter discusses the subject of notification.) The SSCPs and the logical units can then reinitiate the sessions, assuming that the corresponding end users wish to continue communicating and that an alternate route is available.

An LU-LU session may be re-established over an available alternate route in the same class of service, or a different class of service may be specified. (For ACF/VTAM, a different logon mode is required to specify a different class of service since only one class of service is associated with a given logon mode.) If no other virtual route is available in the same or different class of service, the session cannot be re-established. A route must become available in order for the session to be re-established.

Because failure of an explicit route may cause some user data to be lost, the logical units participating in each disrupted LU-LU session must perform resynchronization processing to determine whether data loss occurred and to react accordingly.

One kind of failure in an explicit route—an SDLC link failure—does not cause LU-LU sessions to be disrupted. Because of the way data is queued for a transmission group, the failure (or deactivation) of a link in a multiple-link transmission group causes the data for all sessions using the link to be sent instead over a different link in the same group. Thus, unless the failing link was the only operational link in the group, no sessions are interrupted and no data is lost.

### **Differences in Alternate Routing for Non-SNA Stations (ACF/TCAM Users Only)**

Level 3 of ACF provides the same alternate routing capabilities for non-SNA stations as it does for SNA stations, with the following difference. In ACF/TCAM, non-SNA stations may be specified as eligible or ineligible to participate in cross-domain sessions. (In ACF/VTAM, all non-SNA stations are eligible.) A station specified as eligible is subject to the same class-of-service selection as is an LU-LU session. On the other hand, class-of-service selection is not available for a station specified as ineligible to participate in cross-domain sessions.

### ***Network Flow Control Enhancements***

The flow of data through a network varies from time to time, with the degree of variation depending on the applications for which the network is used, among other factors. In many networks, peak traffic conditions during the conduct of business can be anticipated and planned for. But traffic peaks can also result from such conditions as the failure of a route and the consequent diversion of its traffic to alternate routes. An alternate route may become overburdened with the extra traffic it is asked to carry. Unexpected demands for data transmission by certain end users (terminal operators or application programs) also may impose peak traffic conditions on parts of the network. Thus, not only does the total traffic in a network vary, but the distribution of the traffic in various parts of the network may fluctuate as well.

Whenever the rate at which data is presented to a network exceeds the capacity of the network routes over which the data must flow, data congestion results. Response times may lengthen and throughput may be impaired. Severe or prolonged congestion in one part of a network may be propagated to other parts, causing overall network efficiency to suffer.

Level 3 of ACF has several enhancements to network flow control that can limit data congestion and minimize its effect on network efficiency. On a network-wide basis, access methods (ACF/TCAM and ACF/VTAM) and network control programs continuously monitor data flow and report any congestion to network resources that are using virtual routes that include the congested elements of the network. The resources then react by limiting the amount of data they send over the affected routes until the congestion clears. The monitoring of data flow and limiting of data occur automatically, requiring no action by end users.

Congestion indicators that can be set in path information units are the means of signaling the existence of congestion. For example, a network control program can set a congestion indicator if its queue for a particular transmission group is overloaded or if the program is in slowdown mode because its supply of buffers has been depleted to a predetermined point. The flow control mechanisms of access methods and network control programs in Level 3 of ACF interpret the congestion indicators and automatically modify the algorithms by which they allocate traffic to virtual routes in a way that causes the congestion to dissipate. The term *route pacing* is applied to the monitoring and flow control mechanisms that are applied to virtual routes.

Because any link between network control programs can be owned by any SSCP regardless of location in the network, a single SSCP may be assigned ownership of *all* network resources, including such links. Thus, control of a network containing multiple host processors can be vested in a single host processor, referred to as a communication management processor. A multiple-processor configuration arranged in this way is called a communication management configuration. The advantage of such a configuration is that all the network resources can be defined in a single processor—the communication management processor—thus leaving all other processors in the network free to perform only application processing. The application host processors do not require network resource definitions and do not participate in controlling the network. Determining the locations of problems in the network is made easier because all such activity is the responsibility of the network operator at the communication management processor; coordination between operators at widely dispersed locations is unnecessary. (Network management aids such as the Network Communication Control Facility and the Network Problem Determination Application program products can be useful in isolating and correcting network problems.)

#### **Dynamic NCP Dump for ACF/TCAM**

In Level 3 of ACF, an improved ACF/TCAM dump facility increases the usefulness of storage dumps of network control programs by permitting them to be taken dynamically, that is, without stopping execution of the network control program. This dynamic dump facility allows many error conditions to be diagnosed without interference to network operation. Because the network control program need not be stopped each time a dump is required for diagnostic purposes, network availability is improved.

#### **Line Trace with Transmission Group Option**

The capability to define a transmission group comprising multiple SDLC links between two network control programs is accompanied by a capability to trace the links in the group as a logical entity. Upon request by a network operator, a specified transmission group is traced in a manner equivalent to the trace of a single link. The transmission group option traces all path information units over the link(s) in the group just as though the group were a single link.

#### ***Reducing Cross-Domain Resource Definitions***

Level 3 of ACF simplifies the task of specifying a network by removing the requirement for defining every cross-domain resource to each domain that is to receive session-initiation requests from such resources. Cross-domain resources need only be defined in the domain that initiates the requests. However, the system programmer must identify to each domain that will receive cross-domain, session-initiation requests the domain(s) that are authorized to make such requests. Otherwise, the requests will be rejected.

Besides simplifying the task of specifying a network, this capability facilitates making changes in the network configuration. After a station has been added to a given domain by the dynamic reconfiguration facility, by dialing into a 3705, or by takeover by an SSCP, that station can request a session with a host LU in any other domain, provided that the host LU is defined in the domain of the initiator of the session as a cross-domain resource. Defining that station or its logical units to the other domain beforehand is not necessary, so long as any session-authorization processing performed in the other domain will accept the session-initiation request. This capability is optional; the system programmer may use it for some, all, or none of the cross-domain resources in the network.

#### ***Network Job Entry for JES2 Release 3***

The Network Job Entry facility for Release 3 of the JES2 program product takes advantage of Advanced Communications Function to allow job entry nodes to communicate with each other as if they were directly connected, thereby eliminating

the need for intermediate nodes to store and forward jobs. For information about Network Job Entry for JES2 Release 3, see *Network Job Entry Facility for JES2*, SC23-0008.

### ***Customer Information Control System (CICS/VS)***

Customer Information Control System (CICS/VS) will support the parallel-session capability of ACF/VTAM between interconnected CICS/VS systems. This support can enhance system throughput by permitting more than one transaction to concurrently access resources on a remote CICS/VS system. Information on this subject can be found in *CICS/VS System Programmer's Guide*, SC33-0071, when the CICS/VS support of the parallel-session capability is available.

### ***Advanced Communications Function for VTAM Entry (ACF/VTAME)***

ACF/VTAME is a licensed program product that uses the concepts of Systems Network Architecture and the capabilities of IBM data communication products to accommodate online applications in networks. ACF/VTAME controls access to application programs in its host processor and access to stations defined to ACF/VTAME. ACF/VTAME also allows communication with resources that are controlled by ACF/VTAM or ACF/TCAM in a multiple-domain network.

ACF/VTAME operates with DOS/VSE in an IBM 4331 Processor. The processor may also contain an SDLC or a BSC communications adapter or a combined SDLC-BSC adapter. ACF/VTAME can control communication between the processor and stations attached to a processor data channel or, through the communications adapter, stations attached to SDLC and BSC links.

For information on ACF/VTAME, see *Advanced Communications Function for VTAM Entry General Information: Introduction*, GC27-0438, and *Advanced Communications Function for VTAM Entry General Information: Concepts*, GC27-0451.

## Appendix A. Communication Stations and Systems Supported by ACF Level 3

This appendix lists the communication products supported by the major components of Level 3 of Advanced Communications Function: ACF/TCAM Version 2 Release 3, ACF/VTAM Release 3, and ACF/NCP/VS Release 3. Some of the products listed are not supported by prior levels of ACF, nor by all programming subsystems with which the access methods can communicate. Further, some of the products qualified by footnotes indicating non-support by ACF/VTAM Release 3 are supported by prior versions of ACF/VTAM. For detailed information on communication products supported, consult your IBM representative.

ACF/TCAM, ACF/VTAM, and ACF/NCP/VS support the products listed below when they are connected to a 3705-I or 3705-II communications controller by either non-switched or switched lines, except as noted. Also listed are the communication products supported directly by ACF/VTAM and ACF/TCAM when locally attached to a host processor channel.

### Remote Attachment to Host Processor via 3705-I or 3705-II

The following stations and systems are supported by ACF/NCP/VS in a 3705-I or 3705-II communications controller. (Some of these stations and systems are supported also—or only—as compatible with other stations and systems. See “Compatible Remote Stations” below.)

#### SNA-SDLC Stations and Systems

- IBM 3271 Control Unit (Models 11, 12)<sup>1</sup>
- IBM 3274 Control Unit (Model 1C)<sup>1</sup>
- IBM 3275 Display Station (Models 11, 12)<sup>1</sup>
- IBM 3276 Control Unit Display Station (Models 11, 12, 13, 14)<sup>4</sup>
- IBM 3601 Finance Communication Controller
- IBM 3602 Finance Communication Controller
- IBM 3614 Consumer Transaction Facility<sup>1</sup>
- IBM 3624 Consumer Transaction Facility<sup>1</sup>
- IBM 3651 Store Controller (Models A50, B50)<sup>3</sup>
- IBM 3651 Store Controller (Models A60, B60)<sup>3</sup>
- IBM 3651 Programmable Store Controller (Models 25, 75)
- IBM 3661 Store Controller<sup>2, 3</sup>
- IBM 3684 Point of Sale-Control Unit<sup>3</sup>
- IBM 3730 Distributed Office Communication System (attached via 3791)
- IBM 3767 Communication Terminal (Models 1, 2, 3)
- IBM 3771 Communication Terminal (Models 1, 2, 3)
- IBM 3773 Communication Terminal (Models 1, 2, 3, P1, P2, P3)
- IBM 3774 Communication Terminal (Models 1, 2, P1, P2)
- IBM 3775 Communication Terminal (Models 1, P1)
- IBM 3776 Communication Terminal (Models 1, 2, 3, 4)
- IBM 3777 Communication Terminal (Models 1, 3)
- IBM 3791 Communications Controller
- IBM 6670 Information Distributor
- IBM 8100 Processors (operating under DPPX or DPCX)
- IBM Series/1

<sup>1</sup> Nonswitched lines only

<sup>2</sup> Switched lines only

<sup>3</sup> Not supported by ACF/TCAM, Version 2, Release 3

<sup>4</sup> Not supported by ACF/VTAM, Release 3

### Binary Synchronous (BSC) Stations and Systems

- IBM 1131 Central Processing Unit<sup>4</sup>
- IBM 1826 Data Adapter Unit<sup>4</sup>
- IBM 2715 Transmission Control (Model 2)<sup>4</sup>
- IBM 2772 Multipurpose Control Unit<sup>4</sup>
- IBM 2780 Data Transmission Terminal<sup>4</sup>
- IBM 2972 Station Control Unit (Models 8, 11) (U.S.A. only)<sup>1,4</sup>
- IBM 3271 Control Unit (Models 1, 2)<sup>1</sup>
- IBM 3275 Display Station (Models 1, 2)<sup>1</sup>
- IBM 3735 Programmable Buffered Terminal<sup>4</sup>
- IBM 3741 Data Station (Model 2)<sup>4</sup>
- IBM 3741 Programmable Work Station (Model 4)<sup>4</sup>
- IBM 3747 Data Converter<sup>4</sup>
- IBM 3750 Switching System (World Trade only)<sup>1, 4</sup>
- IBM 5110 Portable Computer<sup>4</sup>
- IBM System/3<sup>4</sup>
- IBM System/360 Model 20<sup>4</sup>
- IBM System/360<sup>4</sup> (Models 25, 30, 40, 50, 65, 67 (in 65 mode), 75, 85, 91, 195)
- IBM System/370 Models 115-168MP<sup>4</sup>

### Start-Stop Stations

- IBM 1051 Control Unit<sup>4</sup>
- IBM 2740 Communication Terminal (Model 1)<sup>5</sup>
- IBM 2740 Communication Terminal (Model 2)<sup>1,4</sup>
- IBM 2741 Communication Terminal<sup>5</sup>
- AT&T 83B3 line control type<sup>1,4</sup>(U.S.A. only)
- Western Union 115A line control type<sup>4</sup>(U.S.A. only)
- CPT-TWX (Models 33, 35) line control type<sup>2,5</sup>(U.S.A. only)
- World Trade teletypewriter (teleprinter) terminals<sup>1, 6</sup>

### Compatible Remote Stations

The following stations are supported by ACF/NCP/VS in a 3705-I or 3705-II communications controller as compatible with the types of stations indicated in parentheses:

### SNA-SDLC Stations

- IBM 3274 Control Unit (Model 1C) (as a 3791)
- IBM 3276 Control Unit Display Station (Models 1, 2, 3, 4) (as a 3791)<sup>4,7</sup>
- IBM 3276 Control Unit Display Station (Models 11, 12, 13, 14) (as a 3791)
- IBM 3631 Plant Communication Controller (as a 3601 or 3602)
- IBM 3632 Plant Communication Controller (as a 3601 or 3602)
- IBM 3771 Communication Terminal (Models 1, 2, 3) (as a 3767)
- IBM 3773 Communication Terminal (Models 1, 2, 3) (as a 3767)
- IBM 3774 Communication Terminal (Models 1, 2) (as a 3767)
- IBM 3775 Communication Terminal (Models 1, 2) (as a 3767)
- IBM 5937 Industrial Terminal (as a 3271 Model 1 or 2)
- IBM 8100 Processors (operating under DPPX or DPCX) (as a 3791)

<sup>1</sup> Nonswitched lines only

<sup>2</sup> Switched lines only

<sup>3</sup> Not supported by ACF/TCAM, Version 2, Release 3

<sup>4</sup> Not supported by ACF/VTAM, Release 3

<sup>5</sup> Supported by ACF/VTAM, Release 3, through Network Terminal Option; when station is attached to switched line, dial-in support only is provided

<sup>6</sup> Supported by ACF/VTAM, Release 3, through Network Terminal Option

<sup>7</sup> With BSC/SDLC switch set to SDLC mode

IBM System/32 (as a 3770)  
IBM System/34 (as a 3770 or 3791, or [ACF/TCAM only] 3767)  
IBM System/38 (as a 3770)

### Binary Synchronous (BSC) Stations

IBM 3274 Control Unit (Model 1C) (as a 3271 Model 1 or 2)  
IBM 3276 Control Unit Display Station (Models 1, 2, 3, 4) (as a 3271 Model 1 or 2)  
IBM 3770 Data Communication System terminals (as a 2772)<sup>4</sup>  
IBM 3780 Data Communication Terminal (as a 2772)<sup>4</sup>  
IBM 5275 Direct Numerical Control Station (as a 3275 Model 1 or 2)<sup>2, 4</sup>  
IBM 5937 Industrial Terminal (as a 3271 Model 1 or 2)  
IBM 6670 Information Distributor (as a 2772)<sup>4</sup>  
| IBM 8100 Processors (operating under DPPX) (as a 3271)<sup>2</sup>  
IBM System/7 Processor Station (as a System/3)<sup>4</sup>  
IBM System/32 Batch Work Station (as a System/3)<sup>4</sup>  
IBM System/34 (as a System/3)<sup>4</sup>  
| IBM System/38 (as a 3770)  
IBM Series/1 (as a System/3)<sup>4</sup>

### Start-Stop Stations

IBM 3767 Communication Terminal (Models 1, 2) (as a 2740 Model 1 or 2 or a 2741)<sup>4</sup>  
IBM 3767 Communication Terminal (Model 3) (as a 2740 Model 2)<sup>4</sup>  
IBM 5100 Portable Computer (as a 2741)<sup>4</sup>  
IBM 5110 Portable Computer (as a 2741)<sup>4</sup>  
IBM Communicating Magnetic Card Selectric ® Typewriter (as a 2741)<sup>4</sup>  
IBM System/7 Processor Station (as a 2740 Model 1)<sup>4</sup>

### Equivalent Remote Stations

Stations that are functionally equivalent to those listed above may also operate satisfactorily with ACF/NCP/VS in combination with ACF/TCAM or ACF/VTAM. The customer is responsible for establishing equivalency.

### Local Attachment to Host Processor via Data Channel

The following stations and systems are supported directly by ACF/TCAM and/or ACF/VTAM, as noted, when attached to a host processor channel. (Some of these stations and systems are supported also—or only—as compatible with other stations and systems. See “Compatible Local Stations” below.)

### SNA Stations and Systems

IBM 3274 Control Unit (Model 1A)  
| IBM 3730 Distributed Office Communication System (attached via 3791)  
IBM 3791 Communications Controller<sup>8</sup>

<sup>1</sup> Nonswitched lines only

<sup>2</sup> Switched lines only

<sup>3</sup> Not supported by ACF/TCAM, Version 2, Release 3

<sup>4</sup> Not supported by ACF/VTAM, Release 3

<sup>5</sup> Supported by ACF/VTAM, Release 3, through Network Terminal Option; when station is attached to switched line, dial-in support only is provided

<sup>6</sup> Supported by ACF/VTAM, Release 3, through Network Terminal Option

<sup>8</sup> ACF/TCAM support requires configuration support 9165 or 9169.

**Non-SNA Stations and Systems**

IBM 2260 Display Station<sup>9</sup>  
IBM 2715 Transmission Control Unit (Model 1)<sup>4</sup>  
IBM 3272 Control Unit (Models 1, 2)  
| IBM 3274 Control Unit (Models 1B, 1D)<sup>4</sup>  
IBM 7770 Audio Response Unit (Model 3)<sup>4</sup>

***Compatible Local Stations***

The following stations are supported as compatible with the types of stations indicated in parentheses when attached to a host processor channel.

**SNA Station**

IBM 3274 Control Unit (Model 1A) (as a 3791)

**Non-SNA Station**

| IBM 3274 Control Unit (Model 1B or 1D) (as a 3272 Model 1 or 2)

***Equivalent Local Stations***

Stations that are functionally equivalent to those listed above may also operate satisfactorily with ACF/TCAM and/or ACF/VTAM when attached to a host processor channel. The customer is responsible for establishing equivalency.

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<sup>4</sup>Not supported by ACF/VTAM, Release 3

<sup>9</sup>Not supported by ACF/VTAM



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