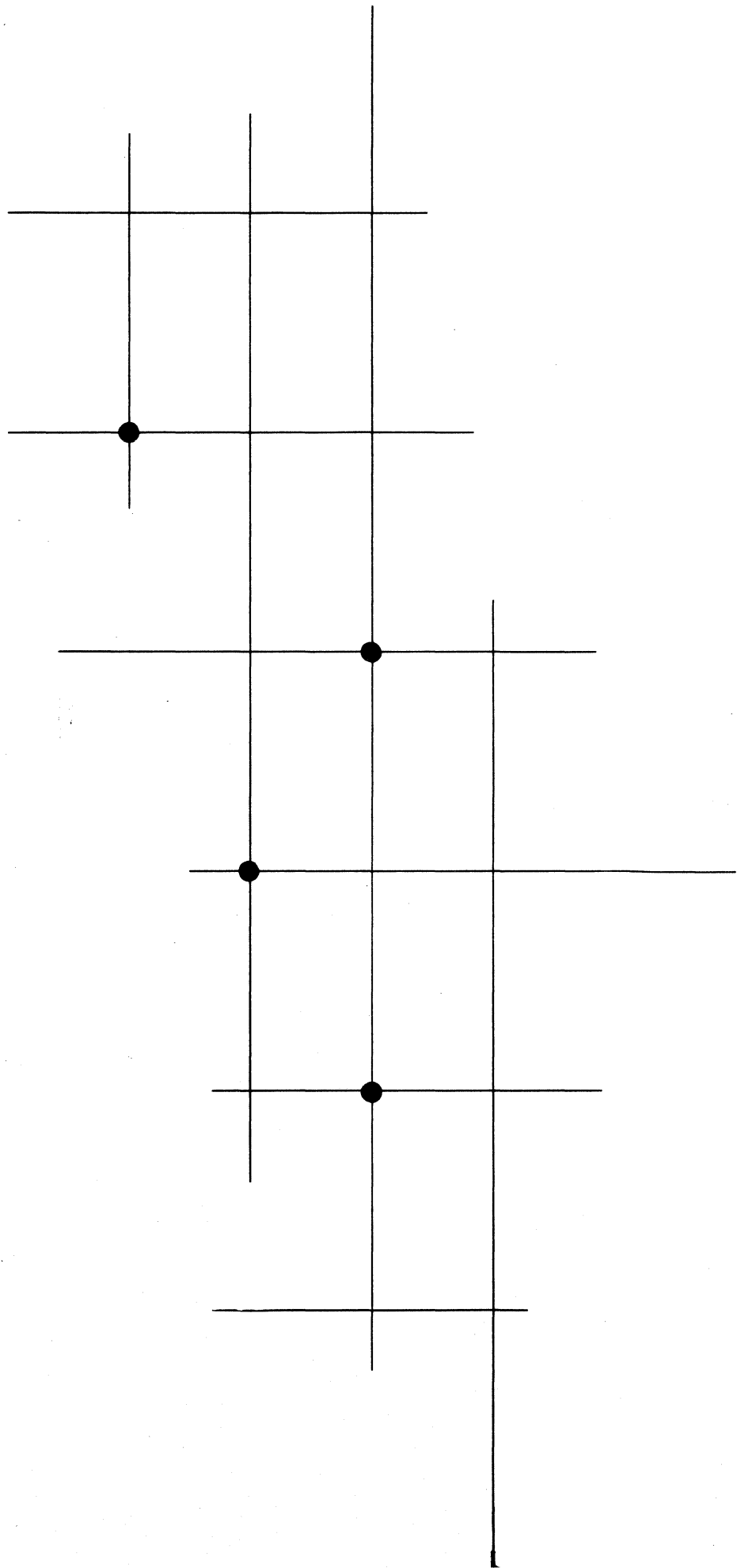


**Systems
Network
Architecture**



**Format and Protocol
Reference Manual:
Architecture Logic For
Type 2.1 Nodes**



SC30-3422-0

First Edition (December 1986)

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PREFACE

This book is intended for product developers, system programmers, and others who need detailed information about Systems Network Architecture (SNA) type 2.1 nodes in order to develop a product or program that implements the architecture.

This book does not describe any specific machines or programs that may implement SNA, nor does it describe any implementation-specific subsets or deviations from the architectural description that may appear within any IBM SNA product. These matters, as well as information on SNA product installation and system definition, are described in the appropriate publications for the particular IBM SNA machines or programs to be used.

The following books should be read in conjunction with this one.

PREREQUISITE PUBLICATIONS

- SNA Concepts and Products, GC30-3072—basic information on SNA for those readers wanting either an overview or a foundation for further study.
- SNA Technical Overview, GC30-3073—additional details on SNA, especially on functions and control sequences; bridges the gap between the most elementary overview of SNA and the detailed descriptions of the formats and protocols.

RELATED PUBLICATIONS

- SNA Format and Protocol Reference Manual: Architectural Logic, SC30-3112—comprehensive information on the formats and protocols of SNA nodes; includes information on the formats and protocols used by type 2.0 nodes in attaching to SNA subarea networks. Type 2.0 and type 2.1 nodes appear the same to the subarea network.
- SNA Reference Summary, GA27-3136—detailed information on SNA formats.
- SNA Format and Protocol Reference Manual: Architecture Logic for LU Type 6.2, SC30-3269—reference information on SNA formats and protocols for LU type 6.2.
- SNA—Sessions Between Logical Units, GC20-1868—reference information on SNA formats and protocols for LU types other than type 6.2.
- IBM SDLC Concepts, GA27-3093—supplementary details of Synchronous Data Link Control.
- IBM Token-Ring Network Architecture Reference, publication number 6165877, available through product centers—details of IBM Token-Ring Network architecture.
- The X.25 Interface for Attaching SNA Nodes to Packet-Switched Data Networks General Information Manual, GA27-3345—overview and details of IBM's support for the CCITT 1980 X.25 recommendation.
- The X.25 1984 Interface for Attaching SNA Nodes to Packet-Switched Data Networks General Information Manual, GA27-3761—overview of IBM's support for the CCITT 1984 X.25 recommendation.

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CHAPTER 1. T2.1 NODE OVERVIEW

USE AND ORGANIZATION OF THIS BOOK

This book, in conjunction with the companion books listed in the Preface, provides a formal definition of a Systems Network Architecture (SNA) type 2.1 node (hereafter referred to as a T2.1 node). This book describes only the peer communications between T2.1 nodes. For details of communication between T2.1 nodes and subarea networks, see the T2.0 node architecture described in SNA Format and Protocol Reference Manual: Architectural Logic.

The T2.1 node is described in the form of a functionally layered system that is decom-

posed into components. These components are described via text, block diagrams, and finite-state machines (FSMs).

The remainder of this chapter first presents key terms and concepts for T2.1 nodes, and then provides a high-level overview of the node's function and components. Chapters 2, 3, and 4 present more details. Appendixes A, B, and C contain, respectively, information on FSM notation and concepts, relevant formats, and the abbreviations (on fold-out pages) used in this document.

TERMS AND CONCEPTS

Exchange Identification (XID)

A basic link unit (BLU) that is used to convey node and link characteristics to an adjacent node is referred to as an Exchange Identification (XID) BLU, or more simply, an XID. XIDs are exchanged between link stations before and during link activation to establish and negotiate link and node characteristics, and after link activation to communicate changes in these characteristics. "Exchange Identification (XID) Information Fields" in Appendix B gives format details.

See "Chapter 2. Configuration Services" for details of XID exchange and negotiation.

Link

A link is the combination of the link connection (the transmission medium) and two link stations, one at each end of the link connection. A link connection can be shared among multiple links in a multipoint configuration.

Address Spaces

For each adjacent link station (ALS) to which a T2.1 node can send message units, a separate path control instance and corresponding address space of local-form session identifiers is maintained. Each path control instance handles addresses only from its corresponding address space.

Local-Form Session Identifier (LFSID)

T2.1 nodes associate each session using a given link with a 17-bit local-form session identifier (LFSID) taken from the address space corresponding to that link.

See "Chapter 4. Path Control" for a discussion of how the LFSID is encoded in the ODAI, OAF', and DAF' fields of the FID2 transmission header (TH). "Chapter 3. Address Space Manager" discusses the LFSID-assignment algorithm.

OVERVIEW OF T2.1 NODE FUNCTION

The T2.1 node allows peer-to-peer connection of distributed processors, and provides the

physical and session-level connectivity required for support of LU 6.2, hereafter

referred to as the LU.¹ Figure 1-1 on page 1-2 shows the basic peer connection of T2.1 nodes.

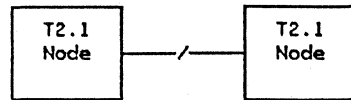


Figure 1-1. Node A Attached to Node B by a Link

DATA LINK CONTROL

The data link control (DLC) used between two T2.1 nodes may be any one of a number of supported DLCs, e.g., IBM token-ring, X.25, or SDLC. A T2.1 node may function as either the primary or secondary station on the link. The link station role, along with other details of the link-level communication, may be negotiated during the initial link-level contact, thereby reducing system-definition requirements for interconnecting T2.1 nodes.

T2.1 nodes exchange XID format 3 (XID3) BLUs to perform role negotiation. Information about the sending node's characteristics is

contained in the XID3, including link station role (primary, secondary, or negotiable), node type, FID type supported on the link, and maximum basic transmission unit (BTU) size that can be received. "Chapter 2. Configuration Services" describes role negotiation.

MULTIPLE LINKS

Activation of multiple links from a T2.1 node to more than one adjacent T2.1 node is also supported. Figure 1-2 illustrates an example of this.

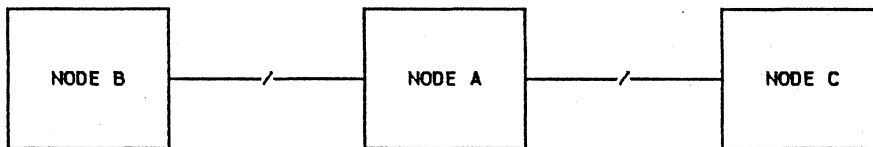


Figure 1-2. A T2.1 Node with Multiple Links

In Figure 1-2, node A has two links, allowing it to communicate concurrently with nodes B and C.

Communication between nodes B and C can be provided through an application-level function in node A.

SESSION CAPABILITIES

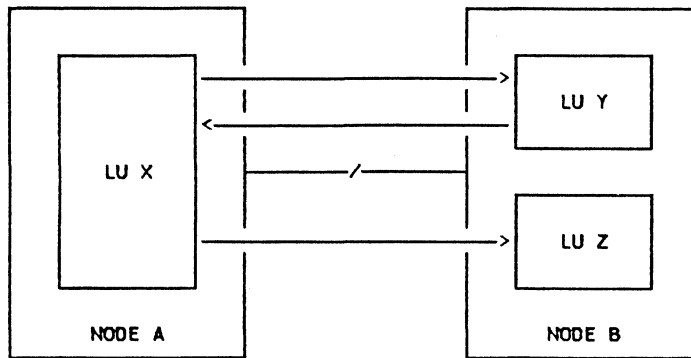
T2.1 nodes support LUs that can both initiate sessions and respond to session initiation requests; a T2.1 node LU is capable of sending and receiving BINDs. The BIND sender is

referred to as the primary LU (PLU); the BIND receiver is referred to as the secondary LU (SLU).

As shown in Figure 1-3 on page 1-3, multiple and parallel sessions may be established by an LU. In the figure, LU X supports parallel sessions with LU Y and a single session with LU Z.

The direction of the session arrows shows the PLU-SLU relationship; in this example, LU X acts as the PLU for the session with LU Z and one of the sessions with LU Y. LU X also acts as the SLU for one of the parallel sessions conducted with LU Y.

¹ Currently, LU 6.2 is the only LU supported.



Key

-/- represents a link between nodes
 — represents a session between LUs

Figure 1-3. Session Capabilities

T2.1 nodes exchange BIND and RSP(BIND) for session initiation, and UNBIND and RSP(UNBIND) for session termination. The BINDs may flow in either direction between two T2.1 nodes at any time after the initial link-level contact. An UNBIND may be sent by either LU.

No request/response units (RUs) other than BIND, UNBIND, RSP(BIND), and RSP(UNBIND) are required by the T2.1 node for session initiation and termination.

TRANSMISSION HEADER USAGE

T2.1 nodes use the 6-byte FID2 TH to transmit all RUs. The LFSID (see "Terms and Concepts"), along with a path control instance identifier (within the node), is used to

identify the particular session on which an RU is flowing. All other fields in the TH are used as defined for the type 2.0 node.

See SNA Reference Summary for format details of the FID2 TH.

REDUCTION OF SYSTEM DEFINITION

Peer-connected T2.1 nodes have fewer system-definition requirements than other nodes. They do not require pre-assigned session addresses, and ACTLU and ACTPU are not required from an external system. Link station roles can be negotiated rather than assigned at system-definition time.

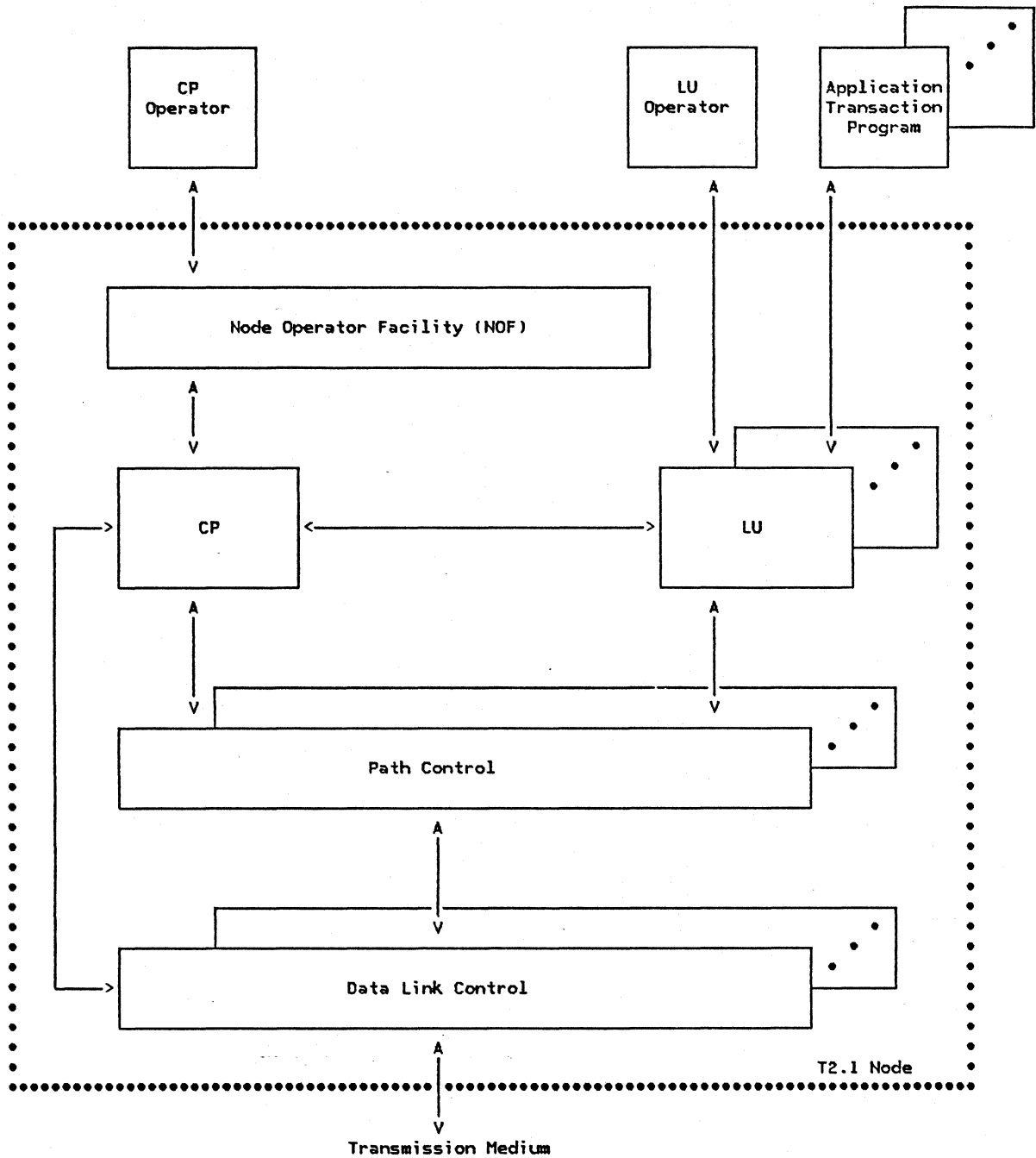


Figure 1-4. First-Level Decomposition of a T2.1 Node

OVERVIEW OF T2.1 NODE COMPONENTS

A T2.1 node consists of the components shown in Figure 1-4: node operator facility (NOF); control point (CP); and multiple instances of logical unit (LU), path control (PC), and

data link control (DLC). An overview of these components is provided in the following sections.

NODE OPERATOR FACILITY (NOF)

NOF's function is to communicate with the CP operator, pass on the operator commands to CP, and initialize the CP components at IPL time. NOF manages requests for such functions as updating and querying CP data bases, activating and deactivating LUs, and activating and deactivating links.

LOGICAL UNIT (LU)

A logical unit serves as a port into the network for one or more application transaction programs.

Consult SNA Format and Protocol Reference Manual: Architecture Logic for LU Type 6.2 for more details on LU 6.2.

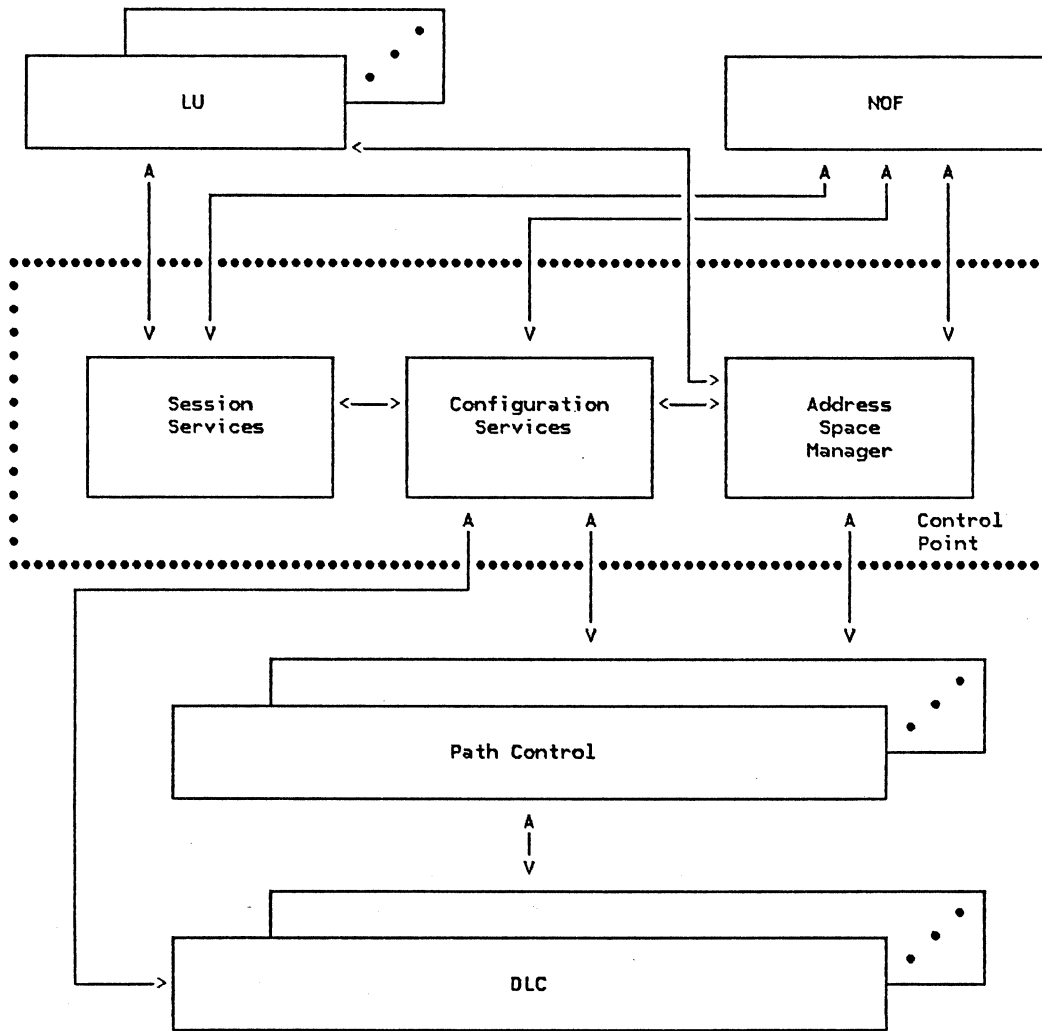


Figure 1-5. Structure of Control Point

CONTROL POINT (CP)

CP's major function is to manage the resources of the T2.1 node. It creates the PC and DLC instances, directs such link-level functions as link activation and deactivation, and assists LUs in session initiation and termination.

The session initiation function requires a directory for the mapping of a destination LU name to its corresponding CP name, and to the specific link used to access the node containing that CP. Every node has its own control point and is responsible for maintaining its own error log.

Within the CP component, three subcomponents exist. These subcomponents—session services

(SS), configuration services (CS), and address space manager (ASM)—and their communication paths with other components are shown in Figure 1-5 on page 1-5. The sections below provide overview information for each of these subcomponents. Since CS and ASM constitute a major portion of the CP function, "Chapter 2. Configuration Services" and "Chapter 3. Address Space Manager" have been devoted to a detailed treatment of their functions.

Session Services (SS)

SS assists LUs with session initiation by providing the following services:

- Maintaining a directory that maps a destination LU name to its corresponding CP name and link.
- Checking with CS that the required link is activated and, if not, requesting that CS activate the link.
- Providing the LU with the path control instance identifier that is associated with the required link.

SS also assists with session-termination processing. A local LU notifies SS whenever one of its sessions terminates. If SS determines that no sessions are using a link, it notifies CS so that the link can be deactivated.

In this book, LU communications with SS are modeled using a direct protocol boundary, rather than via a session as in previous SNA books.

Configuration Services (CS)

CS manages the local links attached to the node and provides the following services:

- Link activation: Upon request from the CP operator (via NOF) or SS, a specified link is activated. This includes exchanging XIDs and negotiating the XID values (e.g., primary-secondary link station roles).
- Link deactivation: Upon request from the CP operator (via NOF) or SS, a specified link is deactivated.
- Link failure processing: When a link connection or link station failure occurs, appropriate cleanup and notification of ASM is performed.

Address Space Manager (ASM)

ASM manages all LFSIDs used by the node. Its functions are:

- Node address control
 - Activate and deactivate address spaces
 - Assign and free LFSIDs for each address space
 - Maintain the relationship between LFSIDs in use and the LUs to which they are assigned
- Session-control initiation and termination message routing
 - Route session-control initiation and termination basic information units (BIUs) between LUs and path control instances (BIND, RSP(BIND), UNBIND, RSP(UNBIND))
- Notify LUs when a link connection or link station failure occurs

ASM performs the session address assignment and routing function that was done by the nodal NAU manager in the LU 6.2 meta-implementation. (See SNA Format and Protocol Reference Manual: Architecture Logic for LU Type 6.2 for details.)

PATH CONTROL (PC)

PC delivers message units between LUs in the same or different nodes and allows LUs to exchange message units without concern for the underlying link characteristics. Path control routes message units between DLCs and LUs. It also performs segment generation and reassembly (if supported) and error checking on message units received from DLC.

"Chapter 4. Path Control" provides a more detailed discussion of path control.

DATA LINK CONTROL (DLC)

DLC provides the protocols necessary for reliable delivery of BTUs between paired link stations in nodes attached to a common link connection. DLC also controls the node attachment to various types of transmission facilities (e.g., switched facilities). It is the only component that communicates directly with the transmission medium.

In this book, each link connection is represented by a DLC instance consisting of a DLC manager and element. The element contains either one secondary link station, or one or more (in the case of a multipoint link connection) primary link stations.

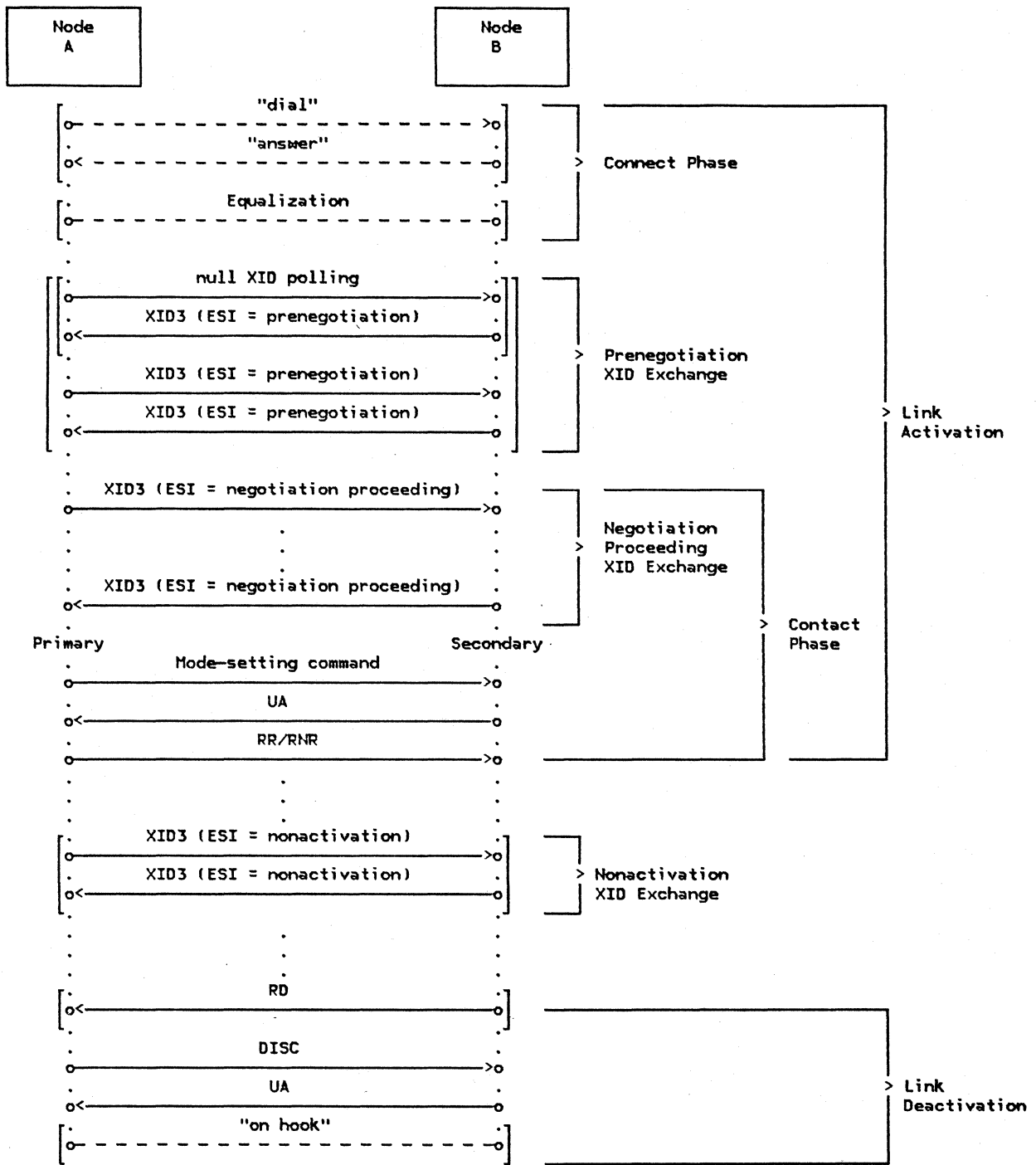
CHAPTER 2. CONFIGURATION SERVICES

INTRODUCTION

The configuration services (CS) component of a T2.1 node activates and deactivates links to adjacent nodes, as well as managing those links. It provides information acquired as a result of its link management functions to the other components of the node.

This introductory section presents an overview of the flows on a link. Later sections

provide considerations for the data base maintained by CS, greater detail on the different stages of the link flows (link activation, nonactivation exchange, link deactivation), a detailed presentation of XID format 3 (XID3) as used by T2.1 nodes, and, finally, certain finite-state machines (FSMs) used by CS.



Note: The exchanges shown during link activation may be sent asynchronously by either node, depending on the type of DLC; they are shown here without crossings or duplication (e.g., both nodes sending a null XID) in order to simplify the diagram. ESI is the Exchange State indicators field discussed in "Rules for Sequencing XIDs" on page 2-7.

Figure 2-1. Overview of CS Link Protocols

CS OVERVIEW

Figure 2-1 outlines the flows on the link between two T2.1 nodes, A and B. Optional flows, as for instance the "dial" sequence initiated by node A, are marked with double brackets. The single braces to the right of the picture indicate the terms applied to various groupings of flows. The sections below define the terms and groupings used in the diagram.

Link Activation

Link activation encompasses the activation of the physical link connection and the link stations. It is comparable to the procedures executed as a result of the ACTLINK and CONTACT commands in the subarea environment, and is composed of up to three phases:

- Connect phase
- Prenegotiation XID exchange
- Contact phase

The connect phase allows initial establishment of communication between nodes. "Dial" and "answer" establish physical layer connection on switched facilities, and may be between modems, on the IBM Token Ring, or over X.25 networks. "Equalization" is the transmission of training sequences that occurs between two modems (see "Modem Equalization" on page 2-6 for further details). Once the connect phase has completed, the two nodes are able to exchange and establish node characteristics via XID commands. (Comparable flows exist for the IBM token ring architecture; see IBM Token-Ring Network Architecture Reference for details.) As indicated in Figure 2-1 on page 2-2 by double brackets, the connect phase and prenegotiation XID exchange are optional flows, based on the characteristics of the link connection and link stations.

A null XID is an XID with an I-field of zero length, and is used to "poll" an adjacent node. Polling is performed in order to determine if the adjacent link station is active; a null XID may be used when the polling node does not know that the polled node is a T2.1 node, i.e., that it can accept an XID3 poll.

During this initial link-activation XID exchange, before link station roles have been determined, the link station roles may be primary, secondary, or negotiable.¹ Primary or negotiable stations may send a null XID. Node B, receiving a null XID, responds with

an XID3 whose Exchange State indicators field (ESI) is set to "Prenegotiation" or "Negotiation Proceeding."

Node A may elect to send a prenegotiation XID3, without a prior null XID, if it is known that node B is able to accept an XID3. With or without a null XID, the optional prenegotiation exchange is concluded after both nodes have sent and received a prenegotiation XID3; the prenegotiation exchange may also be concluded by the receipt of a negotiation-proceeding XID3 in response to a prenegotiation XID3, as described in "Negotiation XID Exchange" on page 2-8.

XID3 negotiation is performed by T2.1 nodes to establish the primary and secondary roles of the link stations, as well as other characteristics of the link. (See "Negotiation XID Exchange" on page 2-8 for details of XID3 negotiation.) The primary-secondary role determines which link station will have control of the link, and is also used in setting the value of the ODAI bit in the LFSID (see "Chapter 3. Address Space Manager").

The negotiation-proceeding XID exchange finishes when link station roles have been established as complementary, i.e., one link station is primary and the other is secondary. The primary link station sends the mode-setting command.

Once the mode-setting command and UA have been sent, and RR or RNR has flowed on the link, the contact and link activation phases are complete.

Nonactivation XID Exchange

A nonactivation XID is an XID3 that is sent after the contact phase has completed. Its purpose is to communicate changes in the characteristics of a link or node. The nonactivation XID3 exchange is currently initiated only by the primary link station. Nonactivation exchanges are discussed in greater detail in "Nonactivation XID Exchange" on page 2-9.

Link Deactivation

Link deactivation can be initiated by either link station (by the primary with the SOLC Disconnect command or by the secondary with the Request Disconnect command) and breaks the connection between the two link stations. The final "on hook" indicates the termination of a switched link connection.

¹ Primary and secondary link station roles for asynchronous balanced mode (ABM) and ABM extended (ABME) stations have no relevance beyond determining which station will send the mode-setting command and how the ODAI bit is set. Considerations for ABM and ABME link stations are discussed in "ABM Support Indicator" on page 2-12.

DATA BASE

A node is responsible for its own local definition of supported LUs, links and their characteristics, node capabilities, and the CP names of nodes that can be directly

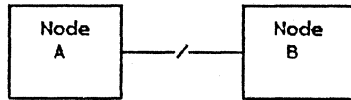


Figure 2-2. Node A Attached to Node B by a Link

In order for LUs at Node A to communicate with LUs at node B, as shown in Figure 2-2, the following information is required at node A:

- Link to node B
- Names of LUs contained at node B

as well as the information below, at node B:

- Link to node A
- Names of LUs contained at node A

SYSTEM DEFINITION OF A LINK

A node requires the following system definition for a local link station:

- Link station role: primary, secondary, or negotiable
- Link station address for any local secondary or negotiable station
- Modem equalization delay value
- Inactivity timer
- Mode-setting command retry limit

In addition, a unique ALS name must be provided for each ALS that can be contacted by the local link station.

Certain nodes not at the current level² of SNA can act only as primary link stations (switched or non-switched) and require the attaching node to always assume the secondary role (never negotiable or primary). The requirement that the attaching node must be secondary is defined by the network installation manager at system definition time in the attaching node.

Where modem equalization is required on a switched link connection, it must be possible at system definition, or no later than link activation time, for the network installation manager to identify any adjacent node that does not delay initial transmission of the

attached; this information is maintained by the CS component in a data base for use by other components of the node.

XID as a called party. "Modem Equalization" on page 2-6 provides a more detailed discussion of this topic.

SYSTEM DEFINITION FOR NONSWITCHED LINK CONNECTIONS.

Nonswitched link connections can be either point-to-point or multipoint. Implementations may provide the ability to add secondary link stations to existing nonswitched point-to-point or multipoint link connections through dynamic reconfiguration. Point-to-point link connections that can be changed to multipoint link connections in this manner are called multipoint-capable link connections.

Coordinated system definition of link station roles and secondary link station addresses is required for operation on a multipoint or a multipoint-capable link connection. For such connections, the following restrictions on link station roles are defined:

- One and only one primary link station exists on the link connection.
- One or more secondary link stations exist on the link connection.
- No negotiable stations may exist on the connection.

Negotiable stations are not usable on multipoint or multipoint-capable link connections; this is because negotiable stations use the broadcast address to avoid defining the secondary address when they do not know which will be the secondary station. Therefore, if a negotiable station is used on a nonswitched point-to-point link connection, the link connection is not multipoint-capable and no additional link stations may be added to the link connection through dynamic reconfiguration.

The predefined primary station on a multipoint or a multipoint-capable nonswitched link connection must be provided information

² "Current level" means as defined in this edition of the architectural specification.

about each secondary station on the link connection. The following system definition information must be provided at the primary station to define an adjacent link station:

- Secondary station address. The primary station must use a specific secondary station addresses. It cannot use the broadcast address on multipoint or multipoint-capable link connections because it would cause multiple secondary stations to respond simultaneously.
- XID type (optional). This information defines the XID format to be used when activating the link. It need not be provided if all link stations on the multipoint link connection use the same XID type or when null XID polling is used.

REDUCING SYSTEM DEFINITION FOR NONSWITCHED LINK CONNECTIONS.

Not all point-to-point nonswitched link con-

nections are multipoint-capable. When at least one of the stations on these connections has a negotiable role, the system definition requirements at both ends may be reduced as follows:

- The local link station role may be defaulted to negotiable.
- The secondary station address of the local link station may be given a default value.
- There is no need to know the secondary link station address of the adjacent link station. If the value is needed, it will be acquired during XID negotiation.
- When null XID polling is used with the broadcast address, there is no need to know the adjacent node type or the XID format type expected by the adjacent node.

LINK ACTIVATION

Upon a request from NOF or SS to activate a link, CS completes the following steps:

1. Creates DLC.
2. Instructs DLC to activate the hardware port.
3. Instructs DLC to send XID3s (using XID3 I-fields provided by CS) to the adjacent link station, and receive back, from DLC, the XID3 I-fields returned by that adjacent link station.
4. If the local link station is primary, instructs DLC to send the mode-setting command.
5. Receives notification from DLC that the contact phase has completed.
6. Creates a path control instance.

On completion of these steps, the link is considered active.

DLC responsibilities during link activation vary based on whether the link station is ABM, ABME, normal response mode (NRM), or NRM extended (NRME), and also upon whether the link station is primary, negotiable, or secondary. Specifics on these variations are given in the following sections, but the general DLC responsibilities during link activation are:

- Function as the endpoint of the link connection.
- Until the hardware port is activated, DLC ignores any received I-frames.

- When the hardware port is activated, assume the state of disconnected mode (DM).
- Until notified by CS, respond to any received BLU with a DM response.
- Receive and execute requests from CS for XID3 exchange and transmission of the mode-setting command.
- Forward responses received on the link to CS.

RULES FOR OPERATION OF NRM LINK STATIONS

An NRM/NRME link station may be configured as primary, negotiable, or secondary. The following rules apply when DLC is activated by CS for both switched and nonswitched SDL connections:

Rules for primary DLC:

- DLC never sends responses.
- On links for which the secondary station address is not assigned at system definition, DLC uses the broadcast address until the station address is received from the secondary link station.
- When DLC sends a command, it starts a response inactivity timer that is reset by receipt of a valid response. (See Synchronous Data Link Control Concepts for details.) If the timer expires, the command is sent again. Commands are re-sent up to the retry limit. For polling on nonswitched link connections, the retry limit may be infinite.

- DLC accepts, as a response to a command sent, any BLU it receives that contains a unique secondary address or the broadcast address in the SDLC header. This acceptance allows connections to be established between link stations that are both capable of assuming the role of the primary link station (negotiable-negotiable, or primary-negotiable). Acceptance also allows one primary link station to receive XIDs from another primary link station. CS can then recognize when two primary stations are trying to contact each other; this is an error situation.
- BLUs received when no Poll bit is outstanding are discarded.
- A primary DLC never sends a mode-setting command with the broadcast address, 'X'FF'.

Rules for negotiable DLC:

- DLC sends commands and responses.
- DLC uses the broadcast address, 'X'FF', in the DLC header of all commands sent until link station roles are determined. If the DLC becomes the primary link station, it continues to use the broadcast address until the station address is received from the secondary link station.
- When DLC sends a command, it starts a response inactivity timer that is reset by receipt of a valid response. If the timer expires, the command is sent again. Commands are re-sent up to an implementation-defined retry limit. For polling on nonswitched link connections, the retry limit may be infinite.
- DLC sends an XID response after receipt of an XID command.
- DLC accepts any BLU it receives that contains the broadcast address in the SDLC header.
- DLC puts its secondary station address in the DLC header of all responses it sends.
- By direction of CS, DLC is able to assume the primary or secondary role.

Rules for secondary DLC:

- DLC never sends commands.
- DLC sends an XID response upon receipt of an XID command.
- DLC always puts its secondary station address in the SDLC header.

Link stations maintain state machines that enable them to distinguish XID commands from responses. A link station does not send a response to a command received from an adjacent link station without allowing CS to process the XID. Link stations pass notification of the receipt of an XID command along with any I-field received to CS, which examines it and the I-field received, changes any fields required by role determination procedures, and returns to DLC the XID to be used in the response.

In order to accommodate implementations not at the current level of SNA, negotiation protocol receive-logic is tolerant of immediate responses from the adjacent link station,

even though immediate responses are never sent.

RULES FOR OPERATION OF ABM LINK STATIONS

For information on ABM/ABME operation of link stations, see the IBM Token-Ring Network Architecture Reference.

OPERATION ON HALF-DUPLEX POINT-TO-POINT CIRCUITS

XID Collision Avoidance

Two link stations with negotiable or primary capabilities may simultaneously transmit their initial XID commands, causing a collision on the link. To avoid this condition, negotiable link stations delay the retransmission of the XID during the polling process by a random amount of time. This randomization continues until a response to a poll has been received. An implementation determines a finite range of timeout values. IBM implementations typically specify timeouts in the range of 2-20 seconds, but allow installation managers to specify their own timeouts.

Modem Equalization

Modem equalization is the transmission of training sequences between two modems after the link connection is established. For example, it is used by modems that meet CCITT recommendation V.27-ter when they are connected on switched 2-wire circuits. Such an equalization procedure is initiated the first time a link station requests its (local) modem to transmit, and consists of a training sequence transmitted to the adjacent modem, allowing the adjacent modem to equalize. This equalization procedure is completed before the local modem gives the link station permission to proceed with the requested transmission. If an adjacent link station attempts to transmit while its modem is receiving the training sequence (i.e., while equalizing), the modem will not be properly equalized.

When a pair of link stations connected on a switched 2-wire circuit have negotiable roles, or one has a negotiable role and the other has a primary role, both stations can request their modems for permission to transmit initial XIDs at almost the same time. To allow modem equalization to complete properly, one of the link stations must delay the transmission of its initial XID for a time period longer than the sum of: the equalization procedure duration and the signal propagation delays. This time period is termed the equalization delay.

By convention, it is the called link station that delays the transmission of its initial XID for this equalization delay. This delay is not required on 4-wire circuits (even for switched link connections), nor is it required for all modem types. It is also not required for link connections on the IBM token-ring or public data networks such as X.25. Since the equalization delay depends upon the modem type, the circuit type, and the signal propagation delays, it must be specified as a system definition parameter; a value of 0 is allowed.

The following conventions are used for modem equalization:

- The called link station always delays its initial transmission for the specified equalization delay.
- The calling link station is always the first to transmit (if it is not defined as secondary).
- A calling link station that is defined as secondary may behave in one of two ways. It may raise request-to-send, to perform its equalization procedure, as soon as the link connection is established, and then wait to transmit its initial XID until it receives an XID from the called link station. Or, it may delay its equalization procedure until after the called link station has performed its equalization procedure and transmitted its initial XID. If the calling link station elects to delay, it will perform its equalization procedure and transmit its initial XID after it receives an XID from the called link station.

A link connection may be established with a node that does not follow the first convention above; a called link station in such a node does not delay transmission of its initial XID for the specified equalization delay. In this case, the calling link station does not attempt to perform its equalization procedure after initial establishment of the link connection. Instead, modem equalization occurs during the normal transmission of the XID. Link connections to such nodes are identified by system definition procedures.

Implementation of these conventions requires a link station to know whether it is the calling or called link station. When auto-call and auto-answer are used, this information may be deduced from the combination of commands received from CS and the modem signals. When manual call and manual answer are used, this information may not be available to the link station. An implementation-defined signal triggered by a user or operator may be required to allow the link station to function properly.

RULES FOR SEQUENCING XIDS

The Exchange State indicators field in the I-field of each XID3 provides the basis for XID sequencing within four contexts:

- Exchange State indicators not supported³
- Prenegotiation
- Negotiation proceeding
- Nonactivation

Nonactivation occurs after the contact phase has completed and is not a part of link activation; it is discussed here for completeness, as the sequencing rules used apply for all four contexts.

The following rules are in effect:

- After a link station sends the initial XID, it sends another XID only in response to a received XID or if an XID has not been received within an implementation-specific timeout limit.
- Activation XID exchanges terminate when link station roles of the link stations complement each other; i.e., one is primary and the other is secondary.

In those cases in which both link stations initiate polling, the polling XIDs may be sent almost simultaneously. Consequently, the resulting XID exchange may have an asynchronous appearance until the link station roles have been resolved.

RULES FOR XID EXCHANGE

The following rules apply to XIDs exchanged during link activation:

1. Null XIDs are sent as commands only for polling purposes
2. T2.1 nodes send only XID3 as a response to an XID command
3. All primary and negotiable link stations are able to accept a null XID as a response. Because the link stations may initiate the link activation XID exchanges independently, a command sent from one station may be interpreted by the other as a response.
4. All defined fields in the XID3 except those involved with negotiation protocols are not subject to change in XID3s that have the ESI set to "Negotiation Proceeding" or "Exchange State Indicators Not Supported."

³ Implementations awaiting a prenegotiation XID recognize this migration condition, consider it as a prenegotiation XID3, and transmit a prenegotiation or negotiation-proceeding XID3.

5. The negotiation phase is complete when each link station has sent and received at least one XID3 with a complementary nonnegotiable role and the ESI set to "Negotiation Proceeding" or "Exchange State Indicators Not Supported."

Prenegotiation XID Exchange

Flows representing prenegotiation exchanges are shown in Figure 2-1 on page 2-2. Within the optional prenegotiation XID exchange, there are two possibilities: the first is the flow beginning with a null XID; the second is the flow that skips the null XID and polls with a prenegotiation XID3. A comparison of these sequences shows that the prenegotiation exchange can be completed more efficiently if an XID3 is used for polling. Therefore, a prenegotiation XID3 is the preferred manner of polling if it is known that the adjacent node supports receipt of XID3s, i.e., is a T2.1 node.

T2.1 nodes poll up to an implementation-specified retry limit or until a response is received from the polled node. If the polled node is ready to enter into an XID exchange, it responds with a prenegotiation or negotiation-proceeding XID3. If the polled node is not ready to negotiate, it may either not respond at all or send a Disconnected Mode response (DM).

Negotiation XID Exchange

As shown in Figure 2-1 on page 2-2, there are two ways to enter the negotiation-proceeding XID exchange: directly, or by means of an optional prenegotiation XID exchange. A T2.1 node that has received a prenegotiation XID3 response to an XID poll may send a negotiation-proceeding XID3.

During this negotiation phase, the link station roles (primary and secondary) are resolved cooperatively by the two link stations. Also, the ODAI value to be used at each node is determined as a result of the link station role negotiation. The algorithms that are employed in determining the values of negotiated XID3 fields are discussed below. The negotiation-proceeding phase not only completes the identification of the node and its adjacent node but also cooperatively determines one or more attributes of the link between the two nodes. The negotiation-proceeding XID exchange concludes when each negotiable field has been resolved and the contact phase completed.

ABM stations are capable of sending a response while a command is still outstanding. During the link activation XID3 exchange, this may result in the receipt of a prenegotiation XID3 after a negotiation-proceeding XID3 has been sent. The appropriate response in this case is to retransmit the negotiation-proceeding XID3 rather than treat the prenegotiation XID3 as

a protocol error. For the same reason, an ABM station may receive an XID3 after a SABM or SABME has been sent.

LINK STATION ROLE NEGOTIATION: During the link activation XID exchange, before link station roles have been determined, the initial link station roles may be primary, secondary, or negotiable. The role of the link station is specified in the XID3 (see "Link Station Role of the XID Sender" on page 2-12 for details) and, together with the adjacent node's link station role, determines whether a link station will negotiate its role. Figure 2-3 shows the extent to which a link station will negotiate for all combinations of link station roles. Only when both stations are negotiable is there any negotiation with respect to link station roles.

When the link station role flags indicate that role negotiation is required, the Node Identification fields (composed of Block Number and ID Number fields; see "Node Identification Field" on page 2-12 for details) in the received and sent XID3s are compared. CS assigns its link station the DLC primary role if its Node Identification field is the greater of the two, and the DLC secondary role if its Node Identification field is the lesser.

If the Node Identification field in a received XID3 is equal to that of the receiving node's XID3, the receiving CS randomizes its Node Identification ID Number field with a value in the range X'00000'-X'FFFFF'. At the same time, it sets the Block Number field to either X'000' or X'FFF', indicating that the Node Identification field does not provide a unique node identification. An XID3 containing the randomized Node Identification field is then transmitted and, on receipt of the XID response from the adjacent link station, the comparison of Node Identification fields is performed again.

A new random node identification ID number will be generated at most twice. If the condition of equality persists after the second randomization, CS will terminate the XID exchange (see "Control Vectors" on page 2-14 for a discussion of control vector X'22').

If as a result of randomizing the ID number the role determination negotiation can be completed, i.e., one node's field has a greater value than the other's, the original values of the Node Identification field in each node's XID3 are restored, after the link station roles have been negotiated.

ROLE CONSIDERATIONS FOR ABM LINK STATION: For ABM stations, primary and secondary link station roles have no relevance beyond determining which station will send the mode-setting command and how the ODAI bit will be set.

ODAI VALUE DETERMINATION: T2.1 nodes must agree on the ODAI that will be used when activating sessions, i.e., when sending BIND. The node with the primary link station sets its ODAI value to 0, while the node with the

		LINK STATION ROLE FLAG RECEIVED		
		<u>Primary</u>	<u>Secondary</u>	<u>Negotiable</u>
LINK STATION ROLE FLAG SENT	<u>Primary</u>	System definition error	Primary	Primary
	<u>Secondary</u>	Secondary	System definition error	Secondary
	<u>Negotiable</u>	Secondary	Primary	Negotiated

Figure 2-3. Outcome of Link Station Role Comparison: The table entries show the outcome for the sending link station. Only in the case that both stations are negotiable is any additional role negotiation necessary.

secondary sets its ODAI value to 1. Thus, the ODAI value is not actually directly nego-

tiated. Rather, it is a by-product of the link station role negotiation.

NONACTIVATION XID EXCHANGE

After completion of the contact phase, or of a prior nonactivation exchange, information at one node associated with a link may change. An XID3 exchange, currently initiated only by the primary link station, is used to communicate these changes. The XID3s sent in these exchanges have their ESI set to "Nonactivation," and the scope of negotiable fields that may change is more limited than in the case of activation exchanges. Currently, only the contents of the Network Name

control vector X'0E', type X'F4', may change in a nonactivation exchange.

Rules for sequencing nonactivation XID exchange are given in "Rules for Sequencing XIDs" on page 2-7.

Figure 2-4 on page 2-10 shows the flows that occur when a primary link station initiates a nonactivation XID3 exchange.

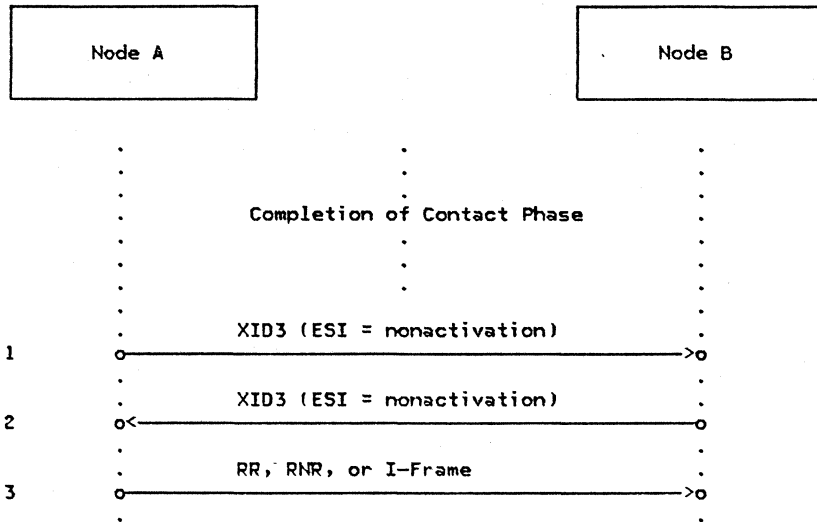


Figure 2-4. Nonactivation XID3 Exchange, Primary Initiated

The following notes are keyed to Figure 2-4.

1. Because of local changes, node A needs to initiate a nonactivation XID exchange. It does so by sending a nonactivation XID3. Since it contains the primary link station, it may send a nonactivation XID3 at any time after the contact phase has completed. The nonactivation XID3 will contain any information about node A that

has changed at its node since the last XID exchange.

2. Node B responds with a nonactivation XID3. It may also convey information changed since the last XID3 exchange.
3. Node A sends an RR, RNR, or I-frame with the Poll bit set to 1, signalling node B that the exchange is completed.

GENERAL RULES FOR ALL DLCS

- The primary initiates a nonactivation exchange by means of an XID3 with the ESI set to "Nonactivation."
- The primary does not initiate a nonactivation exchange when the adjacent node is sending RNR.
- When the primary link station sends a nonactivation XID3, the Poll bit is set to 1.
- When the secondary link station sends a nonactivation XID3, the Final bit is set to 1.

RULES FOR OPERATION OF NRM LINK STATIONS

NRM link stations handle signals from the adjacent node during a nonactivation exchange using the following rules:

- When the primary is sending a nonactivation XID3, any I-frames it has to send are sent before the nonactivation XID3. In this case, the I-frames do not have their Poll bit set to 1 and the XID3 does.
- When a secondary link station that is engaged in a nonactivation exchange receives RR, RNR, or an I-frame with the Poll bit set to 1, it informs CS. This signals the completion of the nonactivation exchange for the secondary link station.

LINK DEACTIVATION

The steps followed by CS when deactivating a link are as follows:

1. CS notifies DLC that the link should be deactivated.
2. CS receives notification that the link is in disconnect mode.
3. CS notifies DLC that the local link station should be destroyed.
4. CS destroys the path control instance associated with the link.

DLC, when told to deactivate the link by CS, performs the DLC command sequences appropriate to its role as primary or secondary link station. (See appropriate DLC document for details.) The primary link station sends

- XID3 is the only response that the secondary link station can send to an XID3 command from the primary link station if the link is to continue. The other secondary link station responses to XID3 (RD, DM, RIM, and FRMR) are treated by the primary link station as errors.
- When an error is detected in the course of a nonactivation exchange, the primary sends Disconnect to initiate the process of deactivating the link.
- When CS enters into a nonactivation exchange, the DLC layer is informed.
- When the secondary link station is responding to a nonactivation XID command, I-frames are not allowed to precede its XID3 response.

RULES FOR OPERATION OF ABM LINK STATIONS

ABM link stations handle signals from the adjacent node during a nonactivation exchange using the following rules:

- After sending a nonactivation XID3 command, the primary can receive and acknowledge RNR, RR, or any I-frame command with the Poll bit set to 1.
- When an error is detected in the course of a nonactivation exchange, either node may send Disconnect to initiate the process of disconnecting the link connection.

Disconnect and receives back UA from the secondary link station. The secondary link station sends Request Disconnect, receives Disconnect from the primary link station, and responds with UA. After either station enters disconnect mode the link connection may be terminated by CS in either node.

If the secondary receives the deactivation command from CS and has other responses pending (such as acknowledgments for received information frames or responses to received unnumbered commands), the RD is not sent immediately. When the Disconnect command from the primary link station is not received because the primary chooses to ignore the RD response, the RD response is repeated at the next response opportunity; incoming frames other than the expected Disconnect are accepted and responded to.

T2.1 USE OF THE XID

A T2.1 node sends only a null XID or an XID3; both are enclosed in a basic link unit (BLU) and each, therefore, consists of a link header, an I-field (in the case of XID3), and a link trailer. The LH indicates that the BLU is an XID. This section highlights those fields and control vectors of the XID that are important to the T2.1 node, as well as the error conditions associated with the use of XID3.

T2.1 nodes ignore unrecognized fields and control vectors received in XID3s, i.e., reserved bits are not checked and unknown control vectors do not cause error conditions. XID3 senders do not echo received unrecognized fields and control vectors.

MAJOR XID3 FIELDS USED BY T2.1 NODES

The following section discusses the major fields of the XID as used by T2.1 nodes; "Appendix B. XID, RUs, Control Vectors, and Sense Data" provides a detailed field-by-field description of XID Format 3 (XID3).

Node Identification Field

This field is composed of two parts, the Block Number and ID Number fields. When the

Node Identification field is not to be taken as a unique node identifier, the Block Number field (bits 0-11 of bytes 2-5) is set to either X'000' or X'FFF'. See "Link Station Role Negotiation" on page 2-8 for a discussion of how this may occur. Otherwise, implementation information is used as indicated in individual implementation specifications.

ABM Support Indicator

The settings of the ABM Support indicator (bit 1 of byte 19) have the following meanings:

- XID sender cannot be a combined ABM station.
- XID sender can be a combined ABM station.

It is an error condition if one station is ABM capable and the other is not. If both stations are ABM capable, link activation is concluded with SABM or SABME as the mode-setting command; if both stations are not ABM capable, the mode-setting command will be SNRM or SNRME. Figure 2-5 summarizes outcomes for the possible sent and received values of the ABM Support indicator.

		XID3 Sender	
		ABM Capable	Not ABM Capable
X I D 3 R e c e i v e r	ABM Capable	Negotiation continues SABM or SABME sent as mode-setting command	Error condition CV X'22' sent on next XID3
	Not ABM Capable	Error condition CV X'22' sent on next XID3	Negotiation continues SNRM or SNRME is sent as mode-setting command

Figure 2-5. Resolution of ABM Capabilities in XID3 Senders and Receivers

Link Station Role of the XID Sender

The settings of the Link Station Role of the XID Sender field (byte 19, bits 2-3) have the

following meanings:

XID sender is a secondary (nonnegotiable) link station.

- XID sender is a primary (nonnegotiable) link station.
- XID sender is a negotiable link station with the capability of being either a primary or secondary link station.

See "Link Station Role Negotiation" on page 2-8 for the details of this role negotiation.

I-Frames Received before Acknowledgment

Bits 1-7 of byte 27 of XID3 contain the specification of the maximum number of I-frames that a link station may receive before it sends an acknowledgment. This field implies the modulus for the send and receive sequence counts. If this field has a value that is

less than 8, the sequence number modulus is 8; otherwise, it is 128.

SDLC CONSIDERATIONS FOR MODULUS RESOLUTION: All SDLC link stations have the capability of using 8 as their modulus. Optionally, a link station may have the capability of using 128. Any link station that can use 128 as its SDLC modulus announces this capability in the activation XID exchange. Such a link station must be prepared to use a modulus of 8 on a link if the adjacent link station declares a modulus of 8. In such a case, the mode-setting command is SNRM instead of SNRME. If the secondary link station does not receive the appropriate command, it responds with DM. Figure 2-6 summarizes the manner in which differences in the modulus numbers for sequence numbers are handled for SDLC and X.25 link stations.

		Station 2	
		8	128
Station	8	SNRM Station 1 Maximum I-Frames before Acknowledgment = as sent Station 2 Maximum I-Frames before Acknowledgment = as sent	SNRM Station 1 Maximum I-Frames before Acknowledgment = as sent Station 2 Maximum I-Frames before Acknowledgment = 7
	128	SNRM Station 1 Maximum I-Frames before Acknowledgment = 7 Station 2 Maximum I-Frames before Acknowledgment = as sent	SNRME Station 1 Maximum I-Frames before Acknowledgment = as sent Station 2 Maximum I-Frames before Acknowledgment = as sent

Figure 2-6. Resolution of Modulus Differences in Maximum Number of I-frames Received before Acknowledgment: For SDLC links, the value sent by either link station does not change in the course of the XID activation exchange. Recognition of differences in the sent and received values is expressed only in the mode-setting command.

Since the value that an SDLC link station sends in this field does not change in the course of the XID exchanges, a link station that alters its capability of using 128 to 8 does not have a chance to declare the maximum number of I-frames that it can receive before acknowledgment. In such cases, it adopts 7 as the maximum number of I-frames received before acknowledgment. And, for its part, the link station that originally declared itself to use a modulus of 8 assumes that the adjacent link station's maximum number of I-frames received before acknowledgment is 7.

IBM TOKEN-RING CONSIDERATIONS FOR MODULUS RESOLUTION: IBM token-ring link stations support only ABME protocols, i.e., they use 128 as a modulus for sequence number counts. Therefore, the maximum number of I-frames a station may receive before acknowledgment does not imply a sequence count. It is possible, for example, that a token-ring link station may send 6 in this field but still will accept or send SABME. Any link station intending to connect to a token-ring link station always uses 128 as a modulus and accepts or receives SABME as a mode setting-command. A token-ring link station will respond to SABM with DM.

X.25 CONSIDERATIONS FOR MODULUS RESOLUTION:
 X.25 link stations support two types of data link control: qualified logical link control (QLLC) and enhanced logical link control (ELLC). ABM corresponds to QLLC, ABME to ELLC, and the choice of ABM or ABME is dependent on system definition. There is no negotiation of modulus values.

PARAMETER ERRORS: A parameter error occurs if one of the link stations declares that 0 is the maximum number of I-frames that it may receive before acknowledgment. In this case, XID3 negotiation is terminated with control vector X'22' on the next XID3 sent.

CONTROL VECTORS

CS appends control vectors at the end of the XID3 and, minimally, the following control vectors are required by sending nodes at the current level of SNA. The absence of these control vectors does not, however, constitute an error condition for a receiving node. This allows T2.1 nodes not at the current level of SNA to attach to current-level nodes.

- Network Name control vector X'0E', type X'F4'—CP Name

The Network Name control vector X'0E', type X'F4', contains the 17-byte network-qualified CP name (see "Control Vectors" in Appendix B for details). As a sender, 1 to 7 bytes of the network identifier is used, although a receiving T2.1 node must accept up to 8 bytes.

The presence of this control vector in a received XID3 is an indicator that the ESI field is supported. See "Rules for Sequencing XIDs" on page 2-7 for a discussion of the ESI field.

- Network Name control vector X'0E', type X'F7'—Adjacent Link Station Name

All XID3s include this control vector.

- Product Set ID control vector X'10'

All XID3s include a Product Set ID control vector of 60 bytes or less in length.

A fourth control vector is used by T2.1 nodes for reporting error conditions:

- XID Negotiation Error control vector X'22'

This control vector is appended to the XID3 when an error has been detected, and contains a pointer to the first byte and first bit of the field in the received XID3 that was in error. The received (erroneous) XID3 is discarded. The presence of control vector X'22' on the received XID3 is a signal that the XID exchange will be terminated.

XID3 EXCHANGE ERRORS

The errors described below are reported to the adjacent node with control vector X'22' appended to the detecting node's XID, except as noted for the invalid station address error. If more than one error is detected, multiple instances of control vector X'22' may be appended as long as the XID3 I-field does not exceed the length restriction of 255 bytes. Control vector X'22' initiates termination of the XID exchange and, whether sent by the primary or secondary, eventually leads to Disconnect being sent by the primary link station. If a node subsequently attempts to reactivate the link is implementation-dependent. See "Control Vectors" for further discussion of control vector X'22'.

XID3 exchange error conditions:

- The XID3 is limited in length to 255 bytes. If an XID3 is received that is longer than this limit, the error can be reported in control vector X'22' with a pointer to bit 0 of byte 256. This check is not required if the DLC will detect the error.
- There is a disagreement between the number of bytes in the XID I-field and the length given in byte 1 of the XID3 I-field.
- Control vector X'0E', type X'F4', is appended to the XID3, but the ESI field is set to exchange state indicators not supported.
- Validation of the CP name in control vector X'0E', when present, is performed.
- Validation of the Node Identification field is performed. See "Node Identification Field" on page 2-12.
- Validation of the DLC type field is performed.
- Validation of the FID type field is performed.
- If XID negotiation has been completed and the station address of the adjacent link station is X'FF', it is an error condition and the link is declared inoperative.
- Incompatibilities in link station roles may occur. See "Link Station Role of the XID Sender" on page 2-12.
- Validation of station type (ABM capable or not) is performed. See "ABM Support Indicator" on page 2-12.
- Validation of the SDLC command/response profile is performed.
- Validation of the Maximum BTU Length field is performed. See "Base Maximum BTU Sizes" in Chapter 4.

- Validation of the Maximum Number of I-Frames before Acknowledgment field is performed. See "I-Frames Received before Acknowledgment" on page 2-13.
- Product implementations may choose to treat certain format errors (e.g., a non-XID3 I-frame received) as DLC errors; after an implementation-defined retry limit is reached, such errors will cause the link to be disconnected.
- The XID negotiation process may begin and not complete properly if one of the two link stations fails to change its role to a nonnegotiable value. Therefore, once a

link station sends a nonnegotiable XID3, it counts the number of received XID3s with negotiable role set. When an implementation-dependent error count is reached, control vector X'22' is sent to the adjacent node.

- In response to a polling null XID or an XID3, T2.1 nodes expect to receive an XID3. If an XID other than XID3 is returned, an XID3 is sent in response. If the ALS persists in returning an XID other than XID3 beyond an implementation-defined retry limit, XID3 with control vector X'22' pointing to the Format Identifier field is returned.

XID3 FINITE-STATE MACHINES

The CS finite-state machines (FSMs) are divided into two groups: activation and non-activation. The sections following discuss each separately. See "Appendix A. FSM Notation" in Appendix A for a discussion of FSM notation.

ACTIVATION XID3 FINITE-STATE MACHINES

The four FSMs that follow for XID negotiation flows are connected together in the following way: FSM_XID3_T2P1_NODE on page 2-17 is a front-end FSM for the other FSMs, and FSM_XID3_NEG_PROTOCOL on page 2-21, FSM_XID3_PRI_PROTOCOL on page 2-25, and FSM_XID3_SEC_PROTOCOL on page 2-27 perform the negotiation. The front-end FSM has a protocol boundary with the DLC manager and the routing and checking logic in CS.

One negotiation FSM exists for each type of station (negotiable, primary, and secondary).

These FSMs also have a protocol boundary with the DLC manager, but the information flows only to the DLC manager. All information from the DLC manager is input to the front-end FSM.

Some general assumptions about the operation of the FSMs are:

- For all links, anything received before link activation is discarded.
- For nonswitched link connections, an XID or mode setting command received after the hardware port has been activated, and before the contact phase has begun, is answered with DM.
- When an error is detected in any of these FSMs, the disconnect procedure is automatically executed.
- The SEND_RECEIVE_DIRECTION is initialized to SEND for these FSMs.

FSM_XID3_T2P1_NODE

FSM_XID3_T2P1_NODE

FUNCTION: This FSM governs that portion of the XID exchange that is not dependent on link station role and provides input to the FSMs that are specific to link station role.

INPUT: The following are the input to this FSM:

ALS_CONNECTED_IN	A signal from the DLC manager that indicates that an incoming call has been received.
ALS_CONNECTED_OUT	A signal from the DLC manager that indicates that a connect-out procedure has been successfully completed.
CONTACT_ALS	A signal from configuration services that initiates the contact phase.
RECVD_XID	A signal from the DLC manager containing the XID3 I-field.
NULL_XID	A signal from the DLC manager indicating that a null XID has been received.
ALS_CONTACTED	A signal from the DLC manager that indicates that a mode-setting sequence has occurred.
RCV_SET_MODE	A signal from the DLC manager that indicates that a mode-setting command has been received.
ALS_DISCONNECTED	A signal from the DLC manager that indicates that link-level contact with an adjacent link station (ALS) has been terminated and that the connection to the ALS has been deactivated.
RESET	A signal indicating that the connection should be considered to be inactive by this finite-state machine.
VARIOUS CONDITIONS	The results of successful Boolean tests on specific XID3 fields. For example, the input ESI_NOT_SUPPORTED indicates that the adjacent link station sets its exchange state indicators to "Exchange State Indicators Not Supported."

OUTPUT: The following are the output from this FSM:

RECVD_XID	A signal containing the XID3 I-field received by the DLC manager. This signal is either passed to configuration services routing and checking logic or to one of the FSMs that are specific to link station role; or to both.
SEND_XID	A signal containing the XID3 I-field to be sent to the adjacent link station (ALS). This signal is passed either to the DLC manager or to one of the FSMs that are specific to link station role. XID3 exchange is currently being conducted.
SEND_RECEIVE_DIRECTION	An internal signal indicating whether the XID3 being passed to the FSM that is link station role specific is an XID3 to be sent (S), an XID3 that has been received (R), or an XID3 used to initialize (I) but that will not be sent.
NULL_XID	The null XID sent to a T2.1 node.

Referenced procedures, FSMs, and data structures:

FSM_XID3_NEG_PROTOCOL	page 2-21
FSM_XID3_PRI_PROTOCOL	page 2-25
FSM_XID3_SEC_PROTOCOL	page 2-27
SEND_RECEIVE_DIRECTION	page 2-36
COMMAND_RESPONSE_RCV_INDICATOR	page 2-36
SEND_XID	page 2-36
RCVD_XID	page 2-37

STATE NAMES---->	START OF SEQ	WAIT RPLY TO NULL XID ON CONN SEQ	RCVD NULL XID	WTNG FOR CONT IN BOTH STAT	WTNG FOR CONT IN ADJ STAT	RCVD XID3 WITH EXCH STATE INDIC NOT SPRTD BFOR CONT	RCVD RCV_ SET_ ON MODE BFOR CONT	ROLE DETR ON CONT SEQ	CONT RCV AFTR RCV_ SET_ MODE	LINK STAT ACTV EXCH COMP	PROTO ERROR	
INPUTS	STATE NUMBERS-->	01	02	03	04	05	06	07	08	09	10	11
ALS_CONNECTED_IN	2 A	/	/	/	/	/	/	/	/	/	/	-
ALS_CONNECTED_OUT	2 A	/	/	/	/	/	/	/	/	/	/	-
CONTACT_ALS	8 H	/	/	5 N	/	8 E	9 E	/	/	/	/	-
RCVD_XID, ESI_NOT_SUPPORTED	/	6 B	6 B	11 K	11 Q	- F	- F	- F	- F	- F	- F	-
RCVD_XID, PRE_NEGOTIATION_EXCHANGE	/	4 L	4 M	- O	- P	11 K	11 K	- C	11 Q	11 Q	-	-
RCVD_XID, NEGOTIATION_PROCEEDING	/	11 K	11 K	- O	8 F	11 K	- F	- F	- F	- F	- F	-
NULL_XID	/	3 C	- C	11 K	11 Q	11 K	- I	- I	- I	- I	- I	-
RCV_SET_MODE	/	11 K	7 D	11 K	11 K	7 I	- I	- I	- I	- I	- I	-
ALS_CONTACTED	/	/	/	/	/	/	/	10 G	10 G	/	/	-
ALS_DISCONNECTED	- J	1 J	1 J	1 J	1 J	1 J	1 J	1 J	1 J	1 J	1 J	1 J
RESET	-	1	1	1	1	1	1	1	1	1	1	1

OUTPUT CODE	FUNCTION
A	<p>(Received ALS_CONNECTED_* as the first input during the connect phase. The link-station-role-specific FSM that will be used throughout the XID exchange is set).</p> <p>Set XID Exchange State field in XID3 to "Prenegotiation Exchange." Select based on Link-Station Role of XID Sender field in SEND_XID: When set to "Negotiable" Set #FSM_XID3_PROTOCOL to FSM_XID3_NEG_PROTOCOL. Send NULL_XID to the DLC manager. Set COMMAND_RESPONSE_RCV_INDICATOR to RESPONSE. When set to "Sender is a Primary Link Station" Set #FSM_XID3_PROTOCOL to FSM_XID3_PRI_PROTOCOL. Send NULL_XID to THE DLC manager. Set COMMAND_RESPONSE_RCV_INDICATOR to RESPONSE. When set to "Sender is a Secondary Link Station" Set #FSM_XID3_PROTOCOL to FSM_XID3_SEC_PROTOCOL. Set COMMAND_RESPONSE_RCV_INDICATOR to COMMAND.</p>
B	<p>(Received an XID3 and the adjacent node set its exchange state indicators to "Exchange State Indicators Not Supported." Verify node ID before calling #FSM_XID3_PROTOCOL to avoid having the ID number affected by randomization.)</p> <p>Send RCVD_XID to configuration services routing and checking logic. As a result, CONTACT_ALS will be an input to this FSM. Set SEND_RECEIVE_DIRECTION to I (Initialize). Call #FSM_XID3_PROTOCOL. Perform output code F.</p>

C	<p>(Answer an XID3 or null XID received with an XID3; one or more retry limits need to be applied here. This action code is used when not engaged in role determination. COMMAND_RESPONSE_RCV_INDICATOR does not change.)</p> <p>Send SEND_XID to the DLC manager.</p>
D	<p>(Received RCV_SET_MODE during connect phase.)</p> <p>Send RECVD_XID I-field to configuration services routing and checking logic. As a result, CONTACT_ALS will be an input to this FSM. Call #FSM_XID3_PROTOCOL. If state of #FSM_XID3_PROTOCOL is PROTO_ERROR then Log error.</p>
E	<p>(Received CONTACT_ALS after the connect phase or following RCV_SET_MODE.)</p> <p>Set XID Exchange State field in SEND_XID to "Negotiation Proceeding." Set SEND_RECEIVE_DIRECTION to S (Send). Call #FSM_XID3_PROTOCOL.</p>
F	<p>(Format and protocol check RECVD_XID; then send the correct response to RECVD_XID.)</p> <p>If state of #FSM_XID3_PROTOCOL is PROTO_ERROR or XID3_ERROR or if state of FSM_XID3_T2P1_NODE is PROTO_ERROR then Send SEND_XID to the DLC manager. Else Save RECVD_XID. Format check and validate the contents of RECVD_XID. If an error exists in the format or field contents then Append an XID Negotiation Error (X'22') control vector to SEND_XID. Set SEND_RECEIVE_DIRECTION to S (Send). Else Set SEND_RECEIVE_DIRECTION to R (Receive). Call #FSM_XID3_PROTOCOL. If state of #FSM_XID3_PROTOCOL is PROTO_ERROR or XID3_ERROR then Log error.</p>
G	<p>(Link station has completed a mode-setting sequence.)</p> <p>Call #FSM_XID3_PROTOCOL.</p>
H	<p>(Received CONTACT_ALS as the first input during the contact phase. The link-station-role-specific FSM that will be used throughout the XID exchange is set).</p> <p>Select based on Link-Station Role of XID Sender field in SEND_XID: When set to "Negotiable" Set #FSM_XID3_PROTOCOL to FSM_XID3_NEG_PROTOCOL. When set to "Sender is a Primary Link Station" Set #FSM_XID3_PROTOCOL to FSM_XID3_PRI_PROTOCOL. When set to "Sender is a Secondary Link Station" Set #FSM_XID3_PROTOCOL to FSM_XID3_SEC_PROTOCOL. Set XID Exchange State field in SEND_XID to "Negotiation Proceeding." Set SEND_RECEIVE_DIRECTION to S (Send). Call #FSM_XID3_PROTOCOL.</p>
I	<p>(Respond to null XID or RCV_SET_MODE in contact phase.)</p> <p>Set SEND_RECEIVE_DIRECTION to R (Receive). Call #FSM_XID3_PROTOCOL. If state of #FSM_XID3_PROTOCOL is PROTO_ERROR then Log error.</p>

J	<p>(The adjacent link station has been disconnected. Reset the FSMs involved in XID3 processing.)</p> <p>Reset #FSM_XID3_PROTOCOL. Reset FSM_XID3_T2P1_NODE.</p>
K	<p>(Received an XID before CONTACT_ALS and one of the following conditions exists: the received XID3 contained the wrong Exchange State field setting, a null XID was received after an XID3, an XID3 was received after RCV_SET_MODE, or an inappropriate mode-setting command was received.)</p> <p>Log error. Append an XID Negotiation Error (X'22') control vector to SEND_XID. Send SEND_XID to the DLC manager.</p>
L	<p>(The first input from the adjacent link station was an XID3. COMMAND_RESPONSE_RCV_INDICATOR does not change value.)</p> <p>Send SEND_XID to the DLC manager. Send RECVD_XID to configuration services routing and checking logic. As a result, CONTACT_ALS will be an input to this FSM.</p>
M	<p>(The first input from the adjacent link station was a null XID.)</p> <p>Send RECVD_XID to configuration services routing and checking logic. As a result, CONTACT_ALS will be an input to this FSM. Select based on COMMAND_RESPONSE_RCV_INDICATOR: When set to COMMAND Send SEND_XID to the DLC manager. When set to RESPONSE Set COMMAND_RESPONSE_RCV_INDICATOR to COMMAND.</p>
N	<p>(Received CONTACT_ALS during the connect phase.)</p> <p>Set XID Exchange State field in XID3 to "Negotiation Proceeding." Select based on COMMAND_RESPONSE_RCV_INDICATOR: When set to COMMAND Set SEND_RECEIVE_DIRECTION to S (Send). Call #FSM_XID3_PROTOCOL. Set COMMAND_RESPONSE_RCV_INDICATOR to RESPONSE. When set to RESPONSE Set SEND_RECEIVE_DIRECTION to I (Initialize). Call #FSM_XID3_PROTOCOL.</p>
O	<p>(An XID3 is received. If COMMAND_RESPONSE_RCV_INDICATOR is set to COMMAND, a response to the received XID3 is sent to the DLC manager. If COMMAND_RESPONSE_RCV_INDICATOR is set to RESPONSE, no response is made, since the XID3 received is the response to the last XID3 in the prenegotiation exchange.)</p> <p>Select based on COMMAND_RESPONSE_RCV_INDICATOR: When set to COMMAND Send SEND_XID to the DLC manager. When set to RESPONSE Set COMMAND_RESPONSE_RCV_INDICATOR to COMMAND.</p>
P	<p>(An XID3 is received during prenegotiation exchange. Polling continues until the adjacent link station begins the negotiation-proceeding phase; a retry limit needs to be applied here.)</p> <p>Send SEND_XID to the DLC manager.</p>
Q	<p>(Received an XID after CONTACT_ALS and one of the following conditions exists: RECVD_XID contained the wrong Exchange State field setting, or a null XID was received after an XID3.)</p> <p>Log error. Append an XID Negotiation Error (X'22') control vector to SEND_XID. Send SEND_XID to the DLC manager.</p>

FSM_XID3_NEG_PROTOCOL

FUNCTION: This FSM describes the protocol for negotiable stations and maintains the state for a T2.1 node regarding the exchange of XID3s for the negotiable station. Additionally, this FSM sends a signal to the DLC manager that corresponds to the input received. When a protocol violation is detected, an XID Negotiation Error control vector is appended to SEND_XID.

INPUT: The following parameters are the input to this FSM:

SEND_RECEIVE_DIRECTION Indicates whether the XID3 being protocol checked by this FSM is an XID3 to be sent (S), an XID3 that has been received (R), or an XID3 used to initialize this FSM to the correct state (I) but that will not be sent.

ROLE_NEGOTIATION_FLAGS When SEND_RECEIVE_DIRECTION is equal to receive (R), the Link-Station Role of XID Sender field in RECVD_XID is examined. This variable takes on the value found in that field, i.e., NEGOTIABLE, PRIMARY_NONNEGOTIABLE, or SECONDARY_NONNEGOTIABLE.

CR_INDICATOR An indicator that the DLC is using a frame format that contains an explicit command/response indicator, e.g., for an ABM DLC.

SEND_XID A signal to the DLC manager containing the XID3 I-field to be sent to the adjacent link station.

NULL_XID A signal that a null XID has been received or that one will be sent, depending upon the value of SEND_RECEIVE_DIRECTION.

RCV_SET_MODE A signal from FSM_XID3_T2P1_NODE that a mode-setting command has been received.

ALS_CONTACTED A signal from FSM_XID3_T2P1_NODE that a mode-setting exchange with an ALS has completed.

RESET A signal indicating that the connection should be considered to be inactive by this finite-state machine.

VARIOUS CONDITIONS The results of successful Boolean tests on specific fields of SEND_XID and/or RECVD_XID. For example, if the Node Identification fields of SEND_XID and RECVD_XID are equal, then NODE_IDS_EQ will be an input to this FSM.

OUTPUT: The following parameters are the output from this FSM:

SEND_XID A signal containing the XID3 I-field to be sent to the adjacent node. During role negotiation, it may be altered in the following manner: when the local node is negotiable, the Link-Station Role of XID Sender field of SEND_XID is altered to assume the negotiated role of "Sender is a Primary Link Station" or "Sender is a Secondary Link Station"; during negotiation, the Node Identification field is altered if XID3 sender and receiver have the same node identification field and both nodes are negotiable; in the event of an error, an XID Negotiation Error control vector is appended.

CONTACT_ALS_PRI/SEC A signal prompting the DLC manager to send (PRI) or answer (SEC) a mode-setting command.

NULL_XID A signal instructing the DLC manager to send a null XID to the adjacent node.

Referenced procedures, FSMs, and data structures:
 SEND_RECEIVE_DIRECTION
 SEND_XID

STATE NAMES---->	RES	NEG PEND	NEG FRST EXCN	NEG SECN EXCN	SEC NO NEG	PRI NO NEG	ROLE DETR COMP SEC 07	ROLE DETR COMP PRI 08	STAT ACTV	PROTO ERROR	XID3 ERROR	
INPUTS	STATE NUMBERS-->	01	02	03	04	05	06	07	08	09	010	011
R, NEGOTIABLE, NODE_IDS_EQ	/	3 B	4 B	10 E	10 F	10 F	10 F	10 F	10 F	-	-	
R, NEGOTIABLE, CR_INDICATOR, RCVD_NODE_ID_EQ_OLD_NODE_ID	/	/	- M	- M	- A	- A	- A	-	10 F	-	-	
R, NEGOTIABLE, SEND_NODE_ID_GT_RCVD_NODE_ID	/	6 C	6 C	6 C	10 F	- A	10 F	10 F	10 F	-	-	
R, NEGOTIABLE, CR_INDICATOR, SEND_NODE_ID_GT_RCVD_NODE_ID	/	6 C	6 C	6 C	10 F	- A	10 F	-	10 F	-	-	
R, NEGOTIABLE, SEND_NODE_ID_LT_RCVD_NODE_ID	/	5 D	5 D	5 D	- A	10 F	10 F	10 F	10 F	-	-	
R, NEGOTIABLE, CR_INDICATOR, SEND_NODE_ID_LT_RCVD_NODE_ID	/	5 K	5 K	5 K	- A	10 F	-	10 F	10 F	-	-	
R, PRIMARY_NONNEGOTIABLE	/	7 J	7 J	7 J	7 A	10 F	- A	10 F	10 F	-	-	
R, PRIMARY_NONNEGOTIABLE, CR_INDICATOR	/	7 J	7 J	7 J	7 L	10 F	- A	10 F	10 F	-	-	
R, SECONDARY_NONNEGOTIABLE	/	6 C	6 C	6 C	10 F	8 G	10 F	10 F	10 F	-	-	
R, SECONDARY_NONNEGOTIABLE, CR_INDICATOR	/	6 C	6 C	6 C	10 F	8 G	10 F	-	10 F	-	-	
R, NULL_XID	/	- A	10 F	10 F	10 F	10 F	10 F	10 F	10 F	-	-	
R, XID3_WITH_CV22	/	11	11	11	11	11	11	10 F	10 F	-	- A	
S, XID3_WITH_CV22	/	11 A	11 A	11 A	11 A	11 A	11 A	10 F	10 F	-	- A	
S, XID3	2 A	-	-	-	- I	-	- I	- G	/	-	-	
S, NULL_XID	2 H	/	/	/	/	/	/	/	/	-	-	
I, NEGOTIABLE	2	/	/	/	/	/	/	/	/	-	-	
RCV_SET_MODE	7 I	7 I	10	10	10	10	-	10	/	-	-	
RCV_SET_MODE, CR_INDICATOR	7 I	7 I	10	10	7 L	10	-	10	/	-	-	
ALS_CONTACTED	/	/	/	/	/	/	9	9	/	-	-	
RESET	-	1	1	1	1	1	1	1	1	1	1	
OUTPUT CODE	FUNCTION											
A	(Send an XID3 to the DLC manager; one or more retry limits need to be applied here.) Send SEND_XID to the DLC manager.											
B	(The XID3 sender and receiver have the same value in the Node Identification field of their respective XID3s. Generate a new ID number, set the block number to either X'000' or X'FFF', and send SEND_XID.) Generate a random ID number. Set block number to X'000' or X'FFF'. Place the random ID number and block number in SEND_XID. Send SEND_XID to the DLC manager.											
C	(Role negotiation has determined this node to be primary-negotiable.) Set the Link-Station Role of XID Sender field in SEND_XID to "Sender is a Primary Link Station." Send SEND_XID to the DLC manager.											

D	<p>(Role negotiation has determined this node to be secondary-negotiable. If the contact procedure has been started by configuration services, direct the DLC manager to accept a mode-setting command.)</p> <p>Set the Link-Station Role of XID Sender field in SEND_XID to "Sender is a Secondary Link Station." If XID Exchange State field in SEND_XID is set to "Negotiation Proceeding" then Send CONTACT_ALS_SEC to the DLC manager.</p>
E	<p>(Randomizing error--the local and remote node have randomized to the same node ID or the nodes are out of synchronization regarding the XID3 exchange. Terminate the XID3 exchange.)</p> <p>Append an XID Negotiation Error (X'22') control vector to SEND_XID. Send SEND_XID to the DLC manager.</p>
F	<p>(Protocol error--terminate XID3 exchange.)</p> <p>Append an XID Negotiation Error (X'22') control vector to SEND_XID. Send SEND_XID to the DLC manager.</p>
G	<p>(XID3 exchange is complete and the local link station is the primary. Signal the DLC manager to send a mode-setting command.)</p> <p>If XID Exchange State field in RECD_XID is set to "Negotiation Proceeding" then Send CONTACT_ALS_PRI to the DLC manager.</p>
H	<p>(Signal the DLC manager to send a null XID.)</p> <p>Send NULL_XID to the DLC manager.</p>
I	<p>(A mode-setting command was received before the contact phase was started by configuration services, or role determination completed before the contact phase was started by configuration services and the contact phase has now begun.)</p> <p>Set the Link-Station Role of XID Sender field in SEND_XID to "Sender is a Secondary Link Station." If XID Exchange State field in RECD_XID is set to "Negotiation Proceeding" then Send CONTACT_ALS_SEC to the DLC manager.</p>
J	<p>(This node's role is as the secondary. It sends the secondary XID3, and when in the contact phase, signal the DLC manager to accept a mode-setting command.)</p> <p>Set the Link-Station Role of XID Sender field in SEND_XID to "Sender is a Secondary Link Station." Send SEND_XID to the DLC manager. If XID Exchange State field in XID3 is "Negotiation Proceeding" then Send CONTACT_ALS_SEC to the DLC manager.</p>
K	<p>Set the Link-Station Role of XID Sender field in SEND_XID to "Sender is a Secondary Link Station." Send SEND_XID to the DLC manager.</p>
L	<p>Send CONTACT_ALS_SEC to the DLC manager.</p>
M	<p>(Result of a resend with an old node ID. Respond with the randomized ID number. Do not compare the current randomized node ID.)</p> <p>Send SEND_XID with the randomized ID number to the DLC manager.</p>

FSM_XID3_PRI_PROTOCOL

FUNCTION:	This FSM describes the protocol for primary link stations and maintains the state for a T2.1 node regarding the exchange of XID3s for the primary link station. Additionally, this FSM sends the correct signal to the DLC manager that corresponds to the input received. When a protocol violation is detected, an XID Negotiation Error control vector is appended to SEND_XID.
INPUT:	The following parameters are the input to this FSM:
SEND_RECEIVE_DIRECTION	Indicates whether the XID3 being protocol checked by this FSM is an XID3 to be sent (S), an XID3 that has been received (R), or an XID3 used to initialize this FSM to the correct state (I) but that will not be sent.
ROLE_NEGOTIATION_FLAGS	When SEND_RECEIVE_DIRECTION is equal to receive (R), the Link-Station Role of XID Sender field in RECVD_XID is examined. This variable takes on the value found in that field, i.e., NEGOTIABLE, PRIMARY_NONNEGOTIABLE, or SECONDARY_NONNEGOTIABLE.
CR_INDICATOR	An indicator that the DLC is using a frame format that contains an explicit command/response indicator, e.g., for an ABM DLC.
SEND_XID	A signal to the DLC manager containing the XID3 I-field to be sent to the adjacent link station.
NULL_XID	A signal that a null XID has been received or that one will be sent, depending upon the value of SEND_RECEIVE_DIRECTION.
RCV_SET_MODE	A signal from FSM_XID3_T2P1_NODE that a mode-setting command has been received.
RESET	A signal indicating that the connection should be considered to be inactive by this finite-state machine.
VARIOUS CONDITIONS	The results of successful Boolean tests on specific fields of SEND_XID and/or RECVD_XID. For example, if the Link Station Role of XID Sender field of RECVD_XID is set to "Negotiable," then NEGOTIABLE will be an input to this FSM.
OUTPUT:	The following parameters are the output from this FSM:
SEND_XID	A signal containing the XID3 I-field to be sent to the adjacent link station. In the event of error, an XID Negotiation Error control vector is appended to SEND_XID.
CONTACT_ALS_PRI	A signal to the DLC manager to send a mode-setting command.
NULL_XID	A signal to the DLC manager to send a null XID to the adjacent link station.

Referenced procedures, FSMs, and data structures:
SEND_XID

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FSM_XID3_PRI_PROTOCOL

STATE NAMES---->	RESET	WAITING FOR RESPONSE TO XID SENT	XID EXCHNG WITH NEGOT OR PRIM STATION 03	XID EXCHNG WITH NEGOT STATION 04	XID EXCHNG WITH SEC STATION 05	ROLE DETERM COMPL PRIM 06	STATION ACTIVE 07	PROTO ERROR 08	XID3 ERROR 09
INPUTS STATE NUMBERS-->	01	02	03	04	05	06	07	08	09
R, NEGOTIABLE	/	4 A	4 A	- A	8 B	8 B	8 B	-	-
R, NEGOTIABLE, CR_INDICATOR	/	4 A	4 A	- A	8 B	-	8 B	-	-
R, PRIMARY_NONNEGOTIABLE	/	8 B	8 B	8 B	8 B	8 B	8 B	-	-
R, SECONDARY_NONNEGOTIABLE	/	5 A	6 C	6 C	6 C	8 B	8 B	-	-
R, SECONDARY_NONNEGOTIABLE, CR_INDICATOR	/	5 A	6 C	6 C	6 C	-	8 B	-	-
R, NULL_XID	/	3 A	4 A	- A	8 B	8 B	8 B	-	-
R, XID3_WITH_CV22	/	9	9	9	9	8 B	8 B	-	- A
S, XID3_WITH_CV22	/	9 A	9 A	9 A	9 A	8 B	8 B	-	- A
S, PRIMARY_NONNEGOTIABLE	3 A	-	-	-	-	- C	/	-	-
S, NULL_XID	2 D	-	-	-	-	-	-	-	-
I, PRIMARY_NONNEGOTIABLE	2	/	/	/	/	/	/	-	-
RCV_SET_MODE	8	8	8	8	8	8	8	-	-
ALS_CONTACTED	/	/	/	/	/	7	/	-	-
RESET	-	1	1	1	1	1	1	1	1

OUTPUT CODE	FUNCTION
A	(Send an XID3 to the DLC manager; one or more retry limits need to be applied here.) Send SEND_XID to the DLC manager.
B	(Protocol error--terminate XID3 exchange.) Append an XID Negotiation Error (X'22') control vector to SEND_XID. Send SEND_XID to the DLC manager.
C	(XID3 exchange is complete and the local link station is primary. Signal the DLC manager to send a mode-setting command.) If XID Exchange State field in SEND_XID is "Negotiation Proceeding" then Send CONTACT_ALS_PRI to the DLC manager.
D	(Signal the DLC manager to send a null XID.) Send NULL_XID to the DLC manager.

FSM_XID3_SEC_PROTOCOL

FUNCTION:	This FSM describes the protocol for secondary link stations and maintains the state for a T2.1 node regarding the exchange of XID3s for the secondary link station. Additionally, this FSM sends the correct signal to the DLC manager that corresponds to the input received. When a protocol violation is detected, an XID Negotiation Error control vector is appended to SEND_XID.
INPUT:	The following parameters are the input to this FSM:
SEND_RECEIVE_DIRECTION	Indicates whether the XID3 being protocol checked by this FSM is an XID3 to be sent (S), an XID3 that has been received (R), or an XID3 used to initialize this FSM to the correct state (I) but that will not be sent.
ROLE_NEGOTIATION_FLAGS	When SEND_RECEIVE_DIRECTION is equal to receive (R), the Link-Station Role of XID Sender field in RECD_XID is examined. This variable takes on the value found in that field, i.e., NEGOTIABLE, PRIMARY_NONNEGOTIABLE, or SECONDARY_NONNEGOTIABLE.
CR_INDICATOR	An indicator that the DLC is using a frame format that contains an explicit command/response indicator, e.g., for an ABM DLC.
SEND_XID	A signal to the DLC manager containing the XID3 I-field to be sent to the adjacent link station.
NULL_XID	A signal that a null XID has been received or that one will be sent, depending upon the value of SEND_RECEIVE_DIRECTION.
RCV_SET_MODE	A signal from FSM_XID3_T2P1_NODE that a mode-setting command has been received.
RESET	A signal indicating that the connection should be considered to be inactive by this finite state machine.
VARIOUS CONDITIONS	The results of successful Boolean tests on specific fields of SEND_XID and/or RECD_XID. For example, if the Link-Station Role of XID Sender field of RECD_XID is set to "Sender is a Primary Link Station," then PRIMARY_NONNEGOTIABLE will be input to this FSM.
OUTPUT:	The following parameters are the output from this FSM:
SEND_XID	A signal containing the XID3 I-field to be sent to the adjacent link station. In the event of an error, an XID Negotiation Error control vector is appended to SEND_XID.
CONTACT_ALS_SEC	A signal to the DLC manager to answer a mode-setting command.

Referenced procedures, FSMs, and data structures:
SEND_XID

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FSM_XID3_SEC_PROTOCOL

STATE NAMES---->	RESET	WAITING FOR XID	XID EXCHANGE WITH NEGOT OR PRIM STATION	XID EXCHANGE WITH NEGOT STATION	ROLE DETRM COMPL SEC	STATION ACTIVE	PROTO ERROR	XID3 ERROR
INPUTS STATE NUMBERS-->	01	02	03	04	05	06	07	08
R, NEGOTIABLE	/	4 A	4 A	- A	7 B	7 B	-	- A
R, PRIMARY_NONNEGOTIABLE	/	5 A	5 A	5 A	- A	7 B	-	- A
R, SECONDARY_NONNEGOTIABLE	/	7 B	7 B	7 B	7 B	7 B	-	- A
R, NULL_XID	/	3 A	- A	7 B	7 B	7 B	-	- A
R, XID3_WITH_CV22	/	8	8	8	8	7 B	-	- A
S, XID3_WITH_CV22	/	8 A	8 A	8 A	8 A	7 B	-	- A
S, SECONDARY_NONNEGOTIABLE	2 C	-	-	-	- C	/	-	/
I, SECONDARY_NONNEGOTIABLE	2	/	/	/	/	/	-	/
RCV_SET_MODE	5 C	5 C	5 C	5 C	-	/	-	-
ALS_CONTACTED	/	6	7 B	7 B	6	/	-	-
RESET	-	1	1	1	1	1	1	1

OUTPUT CODE	FUNCTION
A	(Send an XID3 to the DLC manager; one or more retry limits need to be applied here.) Send SEND_XID to the DLC manager.
B	(Protocol error--terminate XID3 exchange; one or more retry limits should be applied here.) Append an XID Negotiation Error (X'22') control vector to SEND_XID. Send SEND_XID to the DLC manager.
C	(XID3 exchange is complete and this station is secondary. Signal the DLC manager to await a mode-setting command.) If XID Exchange State field in SEND_XID is set to "Negotiation Proceeding" then Send CONTACT_ALS_SEC to the DLC manager.

NONACTIVATION XID3 FINITE-STATE MACHINES

The two FSMs in this section describe the XID3 nonactivation flows. These FSMs have a protocol boundary with the DLC manager and with the routing and checking logic in CS.

The presence of a "LINK NOT ACTIVE" state in each FSM has the sole purpose of demonstrat-

ing that they accept input only after the contact phase has completed.

Both the primary and the secondary nonactivation FSMs show XID3s with detected parameter errors as input. An enumeration of format, parameter, and protocol errors is given in "XID3 Exchange Errors" on page 2-14.

FSM_XID3_NACT_PRI

FSM_XID3_NACT_PRI

FUNCTION: This FSM conducts nonactivation XID3 exchanges for primary link stations. Unless specifically stated otherwise, the node supports Exchange State indicators.

INPUT: The following are the input to this FSM:

ALS_CONTACTED A signal that the data exchange phase has begun.

EXCHANGE_NONACT_XID A signal from CP that a nonactivation XID exchange should be initiated with the adjacent node.

NULL_XID A signal from the DLC manager that a null XID from the adjacent node has been received.

RECVD_XID A signal that the DLC manager has received an XID3 from the adjacent node. The following information may accompany this signal:

- ESI_NOT_SUPPORTED--The sender of the XID3 does not support Exchange State indicators (ESI).
- ESI = ACTIVATION_TYPE--The Exchange State indicators are set either to "Prenegotiation Exchange" or to "Negotiation Proceeding."
- ESI = NON_ACTIVATION--The Exchange State indicators are set to "Nonactivation Exchange."

RESET A signal indicating that the connection should be considered to be inactive by this finite-state machine.

VARIOUS CONDITIONS The results of successful Boolean tests on specific fields of SEND_XID and/or RECVD_XID. For example, if the XID3 Negotiation Error control vector is appended to RECVD_XID, then CV22_APPENDED will be an input to this FSM.

OUTPUT: The following are the output from this FSM:

NONACT_BEGIN A signal to the DLC manager indicating a nonactivation exchange is about to begin.

SEND_XID A signal to the DLC manager containing the contents of an XID3 to be sent to the adjacent node.

NONACT_XID_EXCHANGED A signal sent to CP to report the completion of the nonactivation XID exchange. This signal will contain the following information:

- The adjacent node's CP name.
- The outcome of the nonactivation XID3 exchange, SUCCESS or FAILURE. The signal of a failure in a nonactivation XID3 exchange prompts the primary to send the DISC command.
- Indication whether, or not, the adjacent node sends the CP name in control vector X'0E'.

In nodes with NRM DLCs, receipt of this message prompts signaling the DLC manager that the nonactivation XID3 exchange has been concluded.

Referenced procedures, FSMs, and data structures:
 NONACT_XID_EXCHANGED
 SEND_XID

page 2-36
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STATE NAMES---->	START OF SEQUENCE	ACTIVE PRIMARY STATION	AWAITING XID3 REPLY	ERROR
INPUTS STATE NUMBERS-->	01	02	03	04
ALS_CONTACTED	2	/	/	/
EXCHANGE_NONACT_XID	/	3 A	/	-
NULL_XID	/	4 B	4 B	1 E
RECVD_XID, ESI_NOT_SUPPORTED	/	4 B	2 C	1 E
RECVD_XID, ESI=ACTIVATION_TYPE	/	4 B	4 B	1 E
RECVD_XID, FORMAT_OR_PARAMETER_ERROR	/	4 B	4 B	1 E
RECVD_XID, CV22_APPENDED	/	1 E	1 E	1 E
RECVD_XID, ESI=NON_ACTIVATION	/	4 B	2 D	1 E
RESET	-	1	1	1
OUTPUT CODE	FUNCTION			
A	<p>(Cause the DLC manager to send a nonactivation XID3 to the adjacent link station. This is the first XID3 sent by this node in the nonactivation XID3 exchange. The Exchange State indicator is set to "Nonactivation Exchange" and whatever new information that is currently known is included in the XID3. For example, if the node's CP name has changed, control vector X'0E' carries the new name.)</p> <p>Send NONACT_BEGIN to the DLC manager. Set XID Exchange State field in XID3 to "Nonactivation Exchange." Send SEND_XID to the DLC manager.</p>			
B	<p>(A protocol or parameter error is detected.)</p> <p>Append an XID Negotiation Error (X'22') control vector to SEND_XID. Send SEND_XID to the DLC manager.</p>			
C	<p>(The adjacent node responds to the nonactivation XID3 with an XID3 that has ESI set to "Exchange State Indicators Not Supported." Further nonactivation exchanges are useless. Configuration services routing and checking logic is informed via NONACT_XID_EXCHANGED.)</p> <p>Set NONACT_XID_EXCHANGED.CPNAME_IN_CV0E to NO. Set NONACT_XID_EXCHANGED.EXCHANGE_STATUS to SUCCESS. Send NONACT_XID_EXCHANGED to configuration services routing and checking logic.</p>			
D	<p>(Nonactivation XID3 exchange is completed.)</p> <p>Set NONACT_XID_EXCHANGED.CPNAME_IN_CV0E to YES. Set NONACT_XID_EXCHANGED.CPNAME to adjacent node's CP name. Set NONACT_XID_EXCHANGED.EXCHANGE_STATUS to SUCCESS. Send NONACT_XID_EXCHANGED to configuration services routing and checking logic.</p>			
E	<p>(The unsuccessful conclusion of the nonactivation XID3 exchange is reported to configuration services routing and checking logic to send DISC.)</p> <p>Log error. Set NONACT_XID_EXCHANGED.EXCHANGE_STATUS to FAILURE. Send NONACT_XID_EXCHANGED to configuration services routing and checking logic.</p>			

FSM_XID3_NACT_SEC

FUNCTION: This FSM conducts nonactivation XID3 exchanges for secondary link stations that support Exchange State indicators.

INPUT: The following are the input to this FSM:

ALS_CONTACTED A signal that the data exchange DLC phase has begun.

NULL_XID A signal from the DLC manager that a null XID has been received.

RECVD_XID A signal that the DLC manager has received an XID3 from the adjacent node. The following inputs may accompany RECVD_XID:

- **ESI_NOT_SUPPORTED**--The sender of the XID3 does not support Exchange State indicators (ESI).
- **ESI=ACTIVATION_TYPE**--The Exchange State indicators are set to "Prenegotiation Exchange" or to "Negotiation Proceeding."
- **ESI=NON_ACTIVATION**--The Exchange State indicators are set to "Nonactivation Exchange."
- **ABM_DLC**--The link station supports ABM/ABME protocols.

RCV_NON_XID A signal that the DLC manager has received RR, RNR, or an I-frame with the Poll bit set during a nonactivation XID3 exchange

RESET A signal indicating that the connection should be considered to be inactive by this finite-state machine, e.g., DISC has been received by the DLC manager.

VARIOUS CONDITIONS The results of successful Boolean tests on specific fields of SEND_XID and/or RECVD_XID. For example, if a format or parameter error is detected in RECVD_XID, then FORMAT_OR_PARAMETER_ERROR will be an input to this FSM.

OUTPUT: The following are the output from this FSM:

NONACT_BEGIN A signal to the DLC manager indicating a nonactivation exchange has begun.

SEND_XID A signal to the DLC manager containing the contents of an XID3 to be sent to the adjacent node.

NONACT_XID_EXCHANGED A signal sent to CP to report the completion of the nonactivation XID3 exchange. This signal contains the following information:

- The adjacent node's CP name.
- The outcome of the nonactivation XID3 exchange, SUCCESS or FAILURE. In an NRM/NRME secondary without a response opportunity, the link station awaits the DISC command from the primary after the nonactivation XID3 exchange has failed. When failure notification occurs during an NRM/NRME response opportunity, the secondary station initiates disconnection of the link connection, preferably by resetting the FSM and by using the response opportunity to send DN. In an ABM/ABME secondary, failure notification prompts sending of the DISC command.

In NRM/NRME link stations, NONACT_XID_EXCHANGED prompts a signal to the DLC manager that nonactivation XID3 exchange has been completed.

Referenced procedures, FSMs, and data structures:

NONACT_XID_EXCHANGED
SEND_XID

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page 2-36

STATE NAMES---->	START OF SEQUENCE	ACTIVE SECONDARY STATION	IN NONACT EXCHANGE	ERROR
INPUTS STATE NUMBERS-->	01	02	03	04
ALS_CONTACTED	2	/	/	/
NULL_XID	/	4 B	4 B	- C
RECVD_XID, ESI_NOT_SUPPORTED	/	- C	4 B	- C
RECVD_XID, ESI=ACTIVATION_TYPE	/	4 B	4 B	- C
RECVD_XID, FORMAT_OR_PARAMETER_ERROR	/	4 B	4 B	- C
RECVD_XID, CV22_APPENDED, ABM_DLC	/	1 E	1 E	1 E
RECVD_XID, CV22_APPENDED	/	4 C	4 C	- C
RECVD_XID, ESI=NON_ACTIVATION, ABM_DLC	/	- G	/	1 E
RECVD_XID, ESI=NON_ACTIVATION,	/	3 A	- C	- C
RCV_NON_XID, NRM_DLC	/	/	2 D	1 H
RESET	/	1	1	1 F

OUTPUT CODE	FUNCTION
A	<p>(Cause the DLC manager to send a nonactivation XID3 to the adjacent link station. This is the first non-null XID sent in the nonactivation XID3 exchange. The Exchange State indicators are set to "Nonactivation Exchange" and whatever new information that is currently known should be included in the XID3. For example, if the node's CP name has changed, control vector X'0E' should reflect this fact. At this time, the link station is informed via NONACT_BEGIN that a nonactivation XID3 exchange is taking place.)</p> <p>Send NONACT_BEGIN to the DLC manager. Set XID Exchange State field in XID3 to "Nonactivation Exchange." Send SEND_XID to the DLC manager.</p>
B	<p>(A protocol error occurs or a parameter error in the received XID3 has been detected.)</p> <p>Append an XID Negotiation Error (X'22') control vector on SEND_XID. Send SEND_XID to the DLC manager.</p>
C	<p>(Respond with the last XID3 that was sent.)</p> <p>Send SEND_XID to the DLC manager.</p>
D	<p>(The nonactivation XID3 exchange is concluded.)</p> <p>Set NONACT_XID_EXCHANGED.CPNAME to adjacent node's CP name. Set NONACT_XID_EXCHANGED.EXCHANGE_STATUS to SUCCESS. Send NONACT_XID_EXCHANGED to configuration services routing and checking logic.</p>
E	<p>(A secondary ABM/ABME link station has received an XID3 with a control vector X'22' appended. Internal disconnection procedures can be started. These procedures include prompting the DLC manager to send DISC by means of NONACT_XID_EXCHANGED.)</p> <p>Log error. Set NONACT_XID_EXCHANGED.CPNAME to adjacent node's CP name. Set NONACT_XID_EXCHANGED.EXCHANGE_STATUS to FAILURE. Send NONACT_XID_EXCHANGED to configuration services routing and checking logic.</p>

F	<p>(RESET has been received after an error has been detected. Notify configuration services of the nonactivation exchange failure.)</p> <p>Log error. Set NONACT_XID_EXCHANGED.EXCHANGE_STATUS to FAILURE. Send NONACT_XID_EXCHANGED to configuration services routing and checking logic.</p>
G	<p>(An ABM secondary concludes the nonactivation exchange. It sends its nonactivation XID3 response to the primary and informs configuration services that the exchange is complete.)</p> <p>Send SEND_XID to the DLC manager. Set NONACT_XID_EXCHANGED.CPNAME to adjacent node's CP name. Set NONACT_XID_EXCHANGED.EXCHANGE_STATUS to SUCCESS. Send NONACT_XID_EXCHANGED to configuration services routing and checking logic.</p>
H	<p>(While in the error state an RR, RNR or I-frame (all with the poll bit set) arrives, the NRM secondary station logs the error and sends notification of the nonactivation exchange error to configuration services. This prompts the secondary disconnection of the link connection.)</p> <p>Log error. Set NONACT_XID_EXCHANGED.EXCHANGE_STATUS to FAILURE. Send NONACT_XID_EXCHANGED to configuration services routing and checking logic.</p>

FSM COMMON DATA STRUCTURES

The following data structures are referenced by multiple FSMs.

SEND_RECEIVE_DIRECTION

A variable used internally by the link activation FSMs. A value of S (Send) indicates that the FSM will get its input from SEND_XID; a value of R (Receive), that the FSM will get its input from RECVD_XID; and a value of I (Initialize), that the input will be used to initialize an FSM but will not be sent.

SEND_RECEIVE_DIRECTION: possible values: S (Send), R (Receive), I (Initialize)

COMMAND_RESPONSE_RCV_INDICATOR

A variable used internally by FSM_XID3_T2P1_NODE to determine whether RECVD_XID is to be interpreted as a command or response.

COMMAND_RESPONSE_RCV_INDICATOR: possible values: COMMAND, RESPONSE

NONACT_XID_EXCHANGED

A signal to configuration services to report the completion of a nonactivation XID3 exchange. This signal will prompt configuration services to inform other components of the node, e.g., DLC manager, that the nonactivation XID3 exchange has completed and to pass on any new information obtained in the course of the exchange, e.g., the CP name of the adjacent node.

NONACT_XID_EXCHANGED:

EXCHANGE_STATUS: possible values: SUCCESS, FAILURE

CPNAME_IN_CV0E: possible values: YES, NO

CPNAME: possible values: adjacent node's CP name

SEND_XID

A signal that contains the XID3 I-field to be eventually sent to the DLC manager. Other information used to identify the link station may be included if needed. In this model, a separate set of FSMs exists for each link station.

SEND_XID

XID3 I-field being sent.

RECV_XID

A signal that contains the XID3 I-field sent by the adjacent node. Other information used to identify the link station may be included if needed. In this model, a separate set of FSMs exists for each link station.

RECV_XID

XID3 I-field being received.

CHAPTER 3. ADDRESS SPACE MANAGER

"Address Space Manager (ASM)" in Chapter 1 provides a summary of address space manager (ASM) function. This chapter covers the specifics of local-form session identifier

(LFSID) assignment, as well as ASM's interaction with other components of the T2.1 node.

FUNCTIONAL DESCRIPTION

NODE ADDRESS CONTROL

For an LU to initiate a session with a partner LU, it must have a local-form session identifier (LFSID) and an identifier for the PC instance that is associated with the link for the node containing the partner LU. The LU requests the PC instance identifier from SS, using the partner LU name and mode name, and then uses that identifier to request an LFSID from ASM. For each PC instance, ASM maintains an address space and a list of LFSIDs in use; on receiving the request from the LU, ASM assigns an unused LFSID from the address space associated with the PC instance identifier. The LFSID and path control instance identifier uniquely specify the session within the node and accompany all messages routed between the LU and the path control instance.

Local-Form Session Identifier (LFSID)

The LFSID is composed of:

- A 1-bit OAF'-DAF' Assignor indicator (ODAI).

An ODAI value indicates the half of the address space from which the BIND sender is selecting LFSIDs. It is determined as follows: the node containing the primary link station on the link uses an ODAI of value 0; an ODAI value of 1 indicates that the BIND sender is in the node containing the secondary link station on the link.

- A 16-bit session identifier composed of:
 - An 8-bit session identifier high (SIDH) field
 - An 8-bit session identifier low (SIDL) field

See "Chapter 4. Path Control" for a discussion of how the LFSID is encoded in the ODAI, OAF', and DAF' fields of the FID2 transmission header (TH).

Address Space Management

ASM is notified by CS when a link (identified by its associated PC instance identifier) is activated or deactivated; ASM then creates or destroys, respectively, the appropriate address space. LFSIDs from this address space are assigned in a sequentially increasing order, with re-use of previously released LFSIDs. Re-used LFSIDs are assigned beginning with the lowest available address.

The LFSID assigned to each session is valid only for the duration of the session, and therefore the relationship between LUs and LFSIDs as encoded in the FID2 TH is dynamic.

The following rules apply for the 16-bit session identifier address assignment of LU-LU sessions for BINDs sent by T2.1 nodes on a specific link (where, for example, a value of X'01FE' indicates a SIDH of X'01' and a SIDL of X'FE').

- X'0000'-X'0100' reserved
- X'0101'-X'FEFF' used for LU-LU sessions
- X'FF00'-X'FFFF' reserved

Implementations of T2.1 nodes not at the current level of SNA may use an assignment algorithm different from that described above; i.e., numbers may not be sequentially assigned as the assignment algorithm describes.

NON-SESSION TRAFFIC ROUTING

ASM routes session-activation and -deactivation requests and responses (i.e., BIND or UNBIND) between LUs and the appropriate PC instance. The address spaces maintained by ASM for the path control instances are used in providing the services described below.

Routing from LU to PC

When ASM receives a BIND or UNBIND from an LU, it routes the BIU to the appropriate path control instance.

Routing from PC to LU

When ASM receives a RSP(BIND), UNBIND, or RSP(UNBIND) from PC, it uses the appropriate address space and LFSID to route the BIU to the proper LU. If the LFSID is unknown:

- If the BIU is a response, ASM discards the BIU and ignores it.
- If the BIU is an UNBIND, ASM sends a positive RSP(UNBIND) back to the originator LU.

ASM examines each BIND received from PC and does internal routing of it to the proper LU using the network services SLU Name field (see "Request/Response Units" in Appendix B for format details) in the BIND request.

The network services SLU Name field may be either a network-qualified name or an unqualified name. The unqualified name is a 1- to 8-byte type-A symbol-string (SNA Transaction Programmer's Reference Manual for LU Type 6.2 defines type-A symbol strings) that uniquely identifies the SLU within its network. The PLU may include the network identifier of the SLU in the name field as well. When this is done, the network identifier (also a 1- to 8-byte type-A symbol string) is prefixed to the unqualified SLU name and separated by a period (X'4B'). Thus, the network-qualified name is of the form "NETID.SLUNAME" where "NETID." is optional—and may be 1 to 17 bytes in length. Nodes at the current level of SNA do not send network-qualified SLU names, but are able to receive and interpret them.

The SLU name is always present in BINDs from nodes at the current level of SNA. If the

SLU name is not recognized as being in the node, ASM constructs a negative RSP(BIND) with sense data X'80040000' and returns it to the PLU. For optional support of nodes that do not include the SLU name in the BIND request, ASM in the receiving node may use a local default SLU name. If no default SLU name is provided and no SLU name is in the BIND, a negative RSP(BIND) with sense data X'80040000' is sent back to the PLU.

ASM in the receiving node also determines if the LFSID in the BIND request is already in use in the corresponding address space.

- If it is, ASM constructs a negative RSP(BIND) with sense data X'08150004'.
- If it is not, ASM makes an association between the LFSID and the LU named in the SLU Name field given in the BIND request, marks the LFSID "in use," and routes the BIND request to the LU.

If the BIND is an EXCEPTION REQUEST (EXR, a request RU containing sense data), ASM constructs the appropriate negative response (with the same sense data as in the EXR) and sends it to the originator LU.

Route-Outage Notification

When a route becomes inactive because of a link outage, CS informs ASM. ASM then notifies all affected LUs of the outage and deactivates the address space associated with the link. The LUs are responsible for recovery and notification of all affected LU components and transaction programs.

ERRORS

ASM makes a number of checks for error conditions upon receipt of a BIND; a complete list of these conditions, with corresponding sense data, is given below. See "Sense Data" in Appendix B for details.

- The LFSID received is already in use (X'08150004').
- An invalid LFSID was received (X'800F0000').
- Invalid address combination (X'800F0001').
- No memory available for LFSID tables (X'08120007').

- No buffer available to receive the BIND (X'0812000D').
- ASM is unable to route the BIND to the LU because the LU is not active (X'08010000').
- Unknown SLU name in the BIND, or the BIND has no SLU name and the node has no default SLU name (X'80040000').
- The SLU Name's length exceeds the remaining length of the BIND (X'0835nnnn'), where nnnn is the offset in bytes to the SLU Name Length field.

CHAPTER 4. PATH CONTROL

INTRODUCTION

The path control (PC) component of a T2.1 node delivers message units between LUs in the node and other LUs within or outside the node. It enables an LU to exchange message units without knowledge of the actual link configuration.

One PC instance exists per link and, as shown in Figure 4-1, each PC instance consists of a manager and element component.

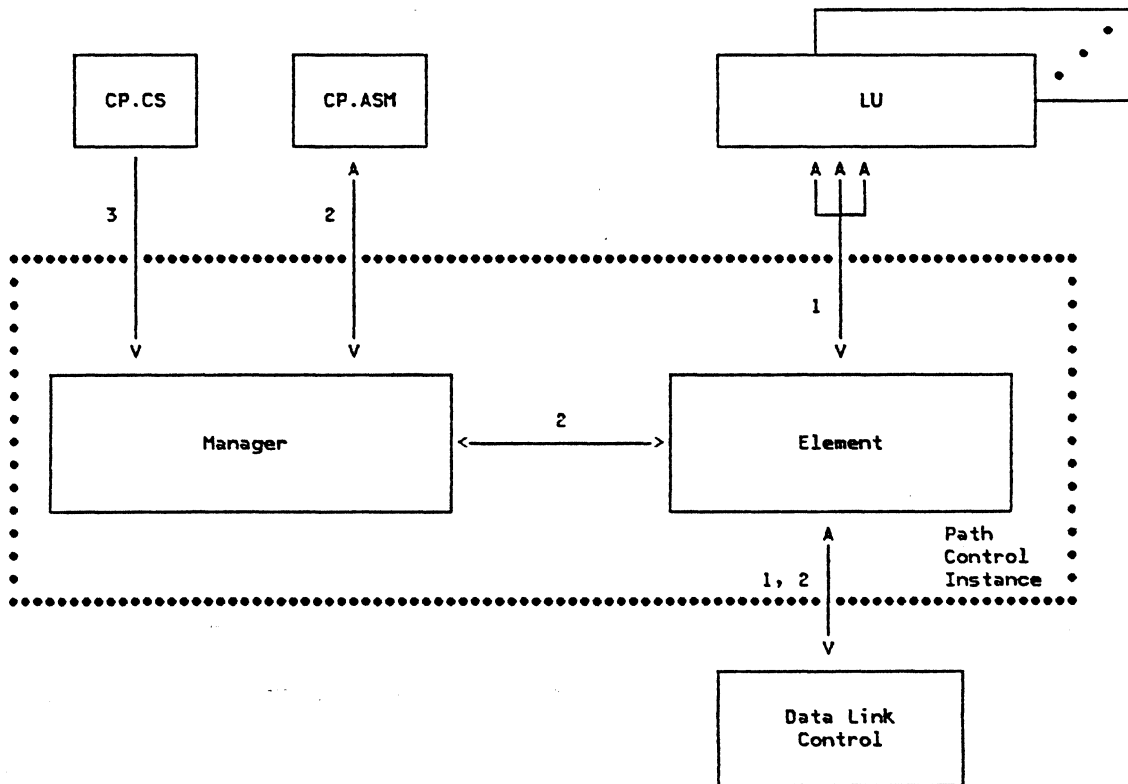


Figure 4-1. Structure of Path Control: The numbered arrows show the routing of different kinds of traffic:

1. Session traffic
2. Non-session traffic (BIND, RSP(BIND), UNBIND, RSP(UNBIND))
3. Create and destroy signals

Note: CP.CS and CP.ASM refer, respectively, to the CS and ASM components contained within the CS component.

The path control manager has PC session activation and deactivation responsibilities. ASM sends session-connection and -disconnection information to a path control manager, causing it to change the set of half-sessions connected to the path control instance.

The path control element is responsible for:

- Message routing: Route messages from path control to LU and DLC components.

In order to perform its routing functions, path control maintains awareness of the half-sessions with which it can exchange message units. Tables showing the relationships between these half-sessions in the node and LFSIDs are used to map incoming and outgoing address fields of the TH.

- Message transformation: Convert message units received from DLC to a form that

can be processed by the CP and LUs; conversely, convert messages received from the CP and LU to a form that can be processed by DLC.

- Segment generation: Generate BIU segments for outbound session traffic when required (done only if segment generation is supported by the node).
- Segment reassembly: Reassemble BIU segments into BIUs from inbound message units when required (done only when segment reassembly is supported).
- Error checking: Perform error checking (e.g., to find TH errors) on message units received from data link control.

The sections below provide more detail on message-unit transformation, segmentation, and error checking performed by path control.

MESSAGE-UNIT TRANSFORMATION AND ROUTING

MESSAGE-UNIT TRANSFORMATION

A path control instance exchanges basic information units (BIUs) with LUs and basic transmission units (BTUs) with data link control. In the T2.1 node, the BTU and path information unit (PIU) are the same, since no PIU blocking is done. A BIU may be converted into one or more PIUs by segmenting it and attaching a FID2 TH field to each segment. Transforming one or more PIUs into a single BIU involves stripping off the THs and performing segment assembly.

A complete description and discussion of the FID2 structure can be found in SNA Reference Summary.

MESSAGE-UNIT ROUTING

The primary purpose of path control is to convey message units between two LUs. If they are in the same node, path control receives a BIU from one LU and delivers it to the other. If they are in different nodes, the path control is distributed between the sending node and the receiving node, as described below.

Transmitting BTUs between Nodes

The path control in a sending node takes a BIU from the LU (session traffic) or ASM (non-session traffic) and transmits the resulting BTUs (one PIU per BTU) to the remote node via the associated adjacent link station. Segmenting of session traffic

request BIUs into one or more PIUs may be done if required and supported by the node.

Routing Received BTUs to LUs

The path control in a receiving node receives BTUs from data link control, reassembles (session traffic) BIU segments within them (when reassembly is supported), and routes the extracted (whole) BIUs either to the appropriate half-session (for session traffic) or ASM (for non-session traffic).

Path control identifies non-session traffic by the RU Category field in the RH and the session-activation or -deactivation request code in the RU; path control routes session traffic to half-sessions by deriving an LFSID from the TH, as described below.

Mapping between LFSID and TH Address Pair

Each session is associated with the 17-bit LFSID (composed of ODAI, SIDH, and SIDL fields), which is assigned by the node containing the primary LU. (See "Chapter 3. Address Space Manager" for a discussion of the LFSID, ODAI, SIDH, and SIDL fields.)

The LFSID is conveyed between two T2.1 path controls in the ODAI, OAF', and DAF' fields of the FID2 TH. The fields of the FID2 TH are set according to the following rules:

- ODAI—This field contains the ODAI of the BIND sender.
- DAF'—This field contains the SIDL for all PIUs that flow in the direction of

the BIND, and the SIDH for all PIUs that flow in the direction of the RSP(BIND).

- OAF'—The OAF' field contains the SIDH for all PIUs that flow in the direction

of the BIND, and the SIDL for all PIUs that flow in the direction of the RSP(BIND).

BIU SEGMENTATION

Session traffic (neither BIND nor UNBIND) is segmented by T2.1 nodes, if segmenting is supported by the node. Segmenting of BIUs into smaller BIU segments is performed by path control in order to transmit message units longer than the maximum-size BTU allowed by a particular link. These segments are reassembled into whole BIUs at the path control of the partner node.

A normal-flow request BIU can be segmented; a response BIU can not. When PC receives a BTU from DLC, the Mapping field (MPF) in the TH indicates whether the BTU contains a whole BIU or a first, middle, or last segment of a BIU. The MPF of a BTU containing a response BIU will always indicate the presence of a whole BIU.

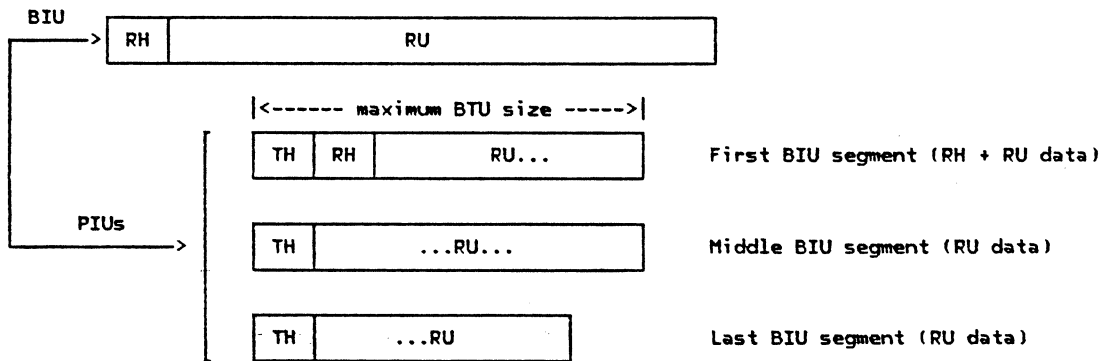
A first segment always contains at least ten bytes of BIU data. The minimum size of 10 accommodates EXRs, which contain a 3-byte RH field, a 4-byte sense data field, and, optionally, 1 byte of RU data. BIUs shorter than 11 bytes are never segmented.

SUPPORT OF SEGMENTING

Segmenting is composed of segment generation and segment reassembly. Segment generation is a prerequisite for segment reassembly, and any node that supports segment reassembly reassembles on a session basis.

SEGMENT GENERATION

A sender segments a BIU if the link receive buffer in the adjacent node is not large enough to allow the node to receive the whole BIU, i.e., the length of the BIU is greater than the adjacent node's maximum receive BTU size would allow. If the length of the BIU is less than or equal to that allowed by the adjacent node's maximum receive BTU size, the BIU is sent whole.



Note: The RU data in the middle and last BIU segments may be three bytes longer than the RU data in the first segment, because each first BIU segment includes the RH.

Figure 4-2. Length of Segments

Segments are generated as illustrated in Figure 4-2. The Mapping field in the TH (for details of the Mapping field, see *SNA Reference Summary*) of each PIU is set to indicate whether the BTU (i.e., PIU) contains the first, middle, or last segment of the BIU. If the BIU has not been segmented, the mapping field indicates that the BTU contains a whole BIU. Path controls of nodes not supporting segmenting make a mandatory check for a mapping field value that does not indicate a whole BIU; if such a value is found, path

control sends a negative response with sense data.

All segments of a BIU have the same sequence number.

The length of each PIU carrying a BIU segment is always equal to or less than the lesser of the node's maximum send BTU size and the adjacent node's maximum receive BTU size (as specified in XID3).

SEGMENT REASSEMBLY

Segment reassembly is done according to the address in the TH of each PIU. Path controls that support segment reassembly do so on a per session basis in order to reassemble segments interleaved from different sessions.

Base Maximum BTU Sizes

SNA specifies an implementation restriction that requires LUs to be able to support an RU size of 256 bytes when sending and receiving RUs. (In some products, network owners may set the RU size to other values; however, the underlying product implementation must always permit the network owner the choice of 256.) With a FID2 TH, an RU size 256 translates to a base maximum BTU size of 265 (6-byte FID2 TH plus 3-byte RH plus 256 bytes of RU). Support of the base BTU size does not preclude support of other BTU sizes.

Segmenting Parameters

The parameters involved in setting up segmenting are found in three places: system definition, XID3, and BIND. These parameters, grouped by location, are:

- System definition
 - Maximum Send BTU size
 - Maximum Receive BTU size
- In XID3
 - Maximum Receive BTU Size field of sending node
- In BIND
 - PLU Maximum Send RU Size field
 - SLU Maximum Send RU Size field

ERRORS

The receiving path control checks for the following errors in BIUs, which are shown with their associated sense data. See "Sense Data" in Appendix B for details.

- Improper FID type (X'80060000')
- Incorrect TH length (X'800B0000')
- Incorrect RH length (X'40050000')
- Incorrect RU length for session control RUs (X'10020000')
- Segmented BIU received by a node that does not support segmenting (X'80070001')

- Whole-BIUs Required indicator

For a particular adjacent link station, a node may support two maximum BTU sizes: maximum receive BTU size, which is the largest BTU the node can receive; and, optionally, maximum send BTU size, which is the largest BTU size it can send. The two need not be equal. If a node has more than one adjacent link station, it may support a different maximum send and receive BTU size for each one. When connecting to another node, a node specifies its own maximum receive BTU size in XID3. Any BIU larger than this size cannot be sent to the node unless it is segmented. A node's maximum send BTU size is an internal parameter, which is not made known to adjacent nodes.

At session activation, a T2.1 node LU specifies in BIND the maximum RU size it can receive on the session. This size is not directly related to the maximum BTU size DLC can receive, but if the maximum RU size is larger, the adjacent node segments BIUs to fit or, if segmentation is not supported, sends smaller BIUs.

Two maximum RU size fields exist in BIND: SLU Maximum Send RU Size (which corresponds to the PLU maximum receive RU size) and PLU Maximum Send RU Size (which corresponds to the SLU maximum receive RU size). A PLU specifies in a BIND request both the PLU and SLU maximum send RU sizes. The SLU may negotiate either of these downward (or upward to 256) in the BIND response.

If segment generation is not supported, the maximum RU sizes are always less than or equal to the DLC's maximum BTU size minus the length of the TH and RH. Negotiation of maximum RU sizes may be required to avoid segment generation when nodes cannot receive segments.

A T2.1 node uses the Whole-BIUs Required indicator in BIND to indicate whether it can receive segments over the session.

- Non-matching sequence numbers in related segments (X'80070000')
- First segment too short (X'80070000')
- Segments out of sequence (X'80070000')
- Session address not recognized (X'80050000')

If an erroneous request BIU indicates that an error response is required, a negative response is returned to the sender, if possi-

ble.¹ Whether or not a response is required, the error is logged and the erroneous BIU is discarded. On receipt of a negative

response, the receiving T2.1 node will send UNBIND.

¹ In some cases, e.g., a garbled TH or RH, a node will not be able to send a response.

APPENDIX A. FSM NOTATION

A finite-state machine (FSM) is a combination of processing and memory, where the memory consists of the state of the FSM. The state can take one of a small number of named values (the state names). An FSM is defined by a matrix that lists the states and specifies the processing to be performed when the FSM is called. This processing typically depends on the current state of the FSM and on the input passed to the FSM, and may change the FSM state (resulting in a state transition) and produce output. Within this matrix definition, each state is given a number as well as its name, for notational convenience.

A number of alternative FSM definitions may be grouped together as a generic FSM, the definition to be used being assigned dynamically. The assignment of a particular definition to be used at a given time is called the binding of the generic FSM. A generic FSM is indicated by a prefixed pound sign (#).

Within FSMs, a naming convention using periods (.) is employed to denote subcomponents of a structure. Another special character, the underscore (_), appears in names to indicate a name phrase rather than decomposition.

The following operations may be performed on an FSM:

- **Call.** Processing is performed as defined in the FSM definition for the existing combination of current state and input. This may involve a state transition.
- **State test.** The current state of the FSM is tested for equality or inequality with a specified value. No state change occurs.

An FSM is represented by a state-transition matrix. The syntax of the state-transition matrix FSM definition is shown in Figure A-1 on page 2. The column headings give the FSM state names, while the row headings name the inputs to the FSMs. The matrix elements—(row,column) intersections—define the state transitions and output actions.

Horizontal lines are used to group input lines together to improve readability. Their location has no bearing on the FSM function. For compactness, mnemonic abbreviations are used in the matrices.

An FSM comes into existence initialized to state 1. If another state is to be the initial state, the FSM is initialized explicitly by calling the FSM with an appropriate signal.

Calling an FSM executes the FSM; i.e., an FSM action code is selected based on the current state of the FSM and the input line that is true. The input line evaluation uses the parameters or signal passed to the FSM. The FSM is scanned for a true input line from top to bottom of the matrix. No more than one input line in a matrix is true during a scan.

If the next-state indicator is a number n, the FSM enters state n. If the next-state indicator is a cannot-occur indicator (/), this is an execution-time error; calls of the FSM cannot encounter this indicator because previous logic has filtered out the input for that state of the FSM.

If no input line is true, the call of the FSM acts as if a no-state-change indicator (-) were encountered.

fname:

STATE NAMES---->		sname	
		[. . .]	. . .
INPUTS	STATE NUMBERS-->	snum	
ic [,ic] . . .		ac	
ic [,ic] . . .		ac	
ic [,ic] . . .		ac	
ic [,ic] . . .		ac	
OUTPUT CODE	FUNCTION		
oc-1	Output logic statements		
	. . .		
oc-n	Output logic statements		

Legend:

[] = optional parameter
 fname = FSM name
 sname = state name component
 snum = state number
 ic = input condition name
 ac = action code
 oc = output code

An action code (ac) has the following possible syntax:

- n{oc} normal state transition to state n (corresponding to some snum) and execution of the function identified by oc
- {oc} same-state transition—remain in the same state
- / "cannot occur" condition, no state change

Figure A-1. Syntax of an FSM State-Transition Matrix

APPENDIX B. XID, RUS, CONTROL VECTORS, AND SENSE DATA

Certain formats and fields used by T2.1 nodes have been updated from SNA Reference Summary; the updated formats are provided here. Sense data provided here are those that appear in the text of this book.

T2.1 nodes ignore unrecognized fields and control vectors received in XID, BIND, UNBIND, RSP(BIND), and RSP(UNBIND), i.e., reserved bits are not checked and unknown control vectors do not cause error conditions. T2.1 nodes do not echo received unrecognized fields and control vectors.

EXCHANGE IDENTIFICATION (XID) INFORMATION FIELDS

- 0 bits 0-3, format of XID I-field:
X'3' variable format (for T2.1 to T2.1 and T2.0 to T4|5 node exchanges): bytes 0-p are included
bits 4-7, type of the XID-sending node:
X'2' T2
- 1 Length, in binary, of variable-format XID I-field (bytes 0-p); reserved for fixed-format XID I-field
- 2-5|7 Node Identification
- 2-5 bits 0-11, block number: an IBM product specific number; see the individual product specifications for the specific values used
Note: The values all 0's and all 1's indicate that bytes 2-5 do not contain a unique node identifier.
bits 12-31, ID number: a binary value that, together with the block number, identifies a specific station uniquely within a customer network installation; the ID number can be assigned in various ways, depending on the product; see the individual product specifications for details
Note: When the Block Number field does not contain all 0's or all 1's, a value of all 0's in the ID number indicates that no ID number has been assigned.
Note: For XID format 3, the contents of bytes 2-5 of the node identification field are used in some instances as a role-negotiation-value to resolve contention in protocol roles of nodes, e.g., primary/secondary DLC roles or the ODAI value to be appended to the (OAF', DAF') values assigned at a node. When a role-negotiation value is needed and the node does not supply a unique node identification value, it supplies a random value in the ID number field.
- End of Format 0
- 6-p Format 3 Continuation
- 6-7 Reserved
- 8-9 Characteristics of the node of the XID sender:
bit 0, INIT-SELF support:
0 INIT-SELF may be sent to the XID sender
Note: If the XID sender does not contain an SSCP, it forwards any INIT-SELF received to the proper node for processing, which returns the response to the originator of the request.
1 INIT-SELF (and character-coded logon) cannot be sent to the XID sender
Note: For bits 0-1, the value 11 is reserved.
bit 1, stand-alone BIND support:
0 BIND may be sent to the XID sender without a prior INITIATE sequence
1 BIND may not be sent to the XID sender
Note: For bits 0-1, the value 11 is reserved.
bits 2-3, retired, set to 11
bits 4-7, FID types that the node supports on this link:
X'0' FID2
bit 8, retired
bits 9-11, reserved
bits 12-13, XID exchange state:
00 exchange state indicators not supported (set only by implementations not at the current level of SNA)
01 negotiation-proceeding
10 prenegotiation exchange
11 nonactivation exchange
bits 14-15, reserved
- 10-16 Reserved
- 17 DLC type:
X'01' SDLC (only value defined)

18-n DLC Dependent Section
 18 Length, in binary, of the DLC Dependent Section field (Length field includes itself in the length specified.)
 19 Link Station and Connection Protocol Flags
 19 bit 0, reserved
 bit 1, ABM support indicator:
 0 XID sender cannot be an ABM combined station
 1 XID sender can be an ABM combined station
 bits 2-3, link-station role of XID sender:
 00 sender is a secondary link station (nonnegotiable)
 01 sender is a primary link station (nonnegotiable)
 10 reserved
 11 negotiable (primary or secondary capability)
 Note: For ABM stations, the value of bits 2-3 is used only for the purposes of OAF'-DAF' assignment and deciding which node sends the Set Mode command.
 bits 4-5, reserved
 bits 6-7, link-station transmit-receive capability:
 00 two-way alternating
 01 two-way simultaneous
 20 Reserved
 21-22 Maximum BTU length that the XID sender can receive:
 bit 0, format flag:
 0 bits 1-15 contain the maximum BTU length (only value defined)
 bits 1-15, maximum BTU length, in binary
 23 bits 0-3, reserved
 bits 4-7, SDLC command/response profile:
 X'0' SNA link profile (only value defined)
 Note: These profiles refer to the mandatory command/response support on an SDLC link, as follows:

- For an SDLC link in normal response mode (NRM/NRME), having a point-to-point or multipoint configuration (determined from system definition), the support required is:

<u>Commands</u>	<u>Responses</u>
I-frames	I-frames
RR	RR
RNR	RNR
Test	Test
XID	XID
SNRM/SNRME	UA
Disconnect	DM
-	RD
-	Frame Reject
Reject	Reject

Note 1: The RD response is sent by the secondary station if and only if CS has decided to deactivate the link.

Note 2: Reject is required only if both sender and receiver have two-way simultaneous transmit-receive capability.

- For an SDLC link in normal response mode (NRM), having a loop configuration (determined from system definition), the support required is:

<u>Commands</u>	<u>Responses</u>
I-frames	I-frames
RR	RR
RNR	RNR
Test	Test
XID	XID
SNRM	UA
Disconnect	DM
UP	-
-	Frame Reject
Configure	Configure
-	Beacon
-	RD

Note: The RD response is sent by the secondary station if and only if CS has decided to deactivate the link.

- For an SDLC link in asynchronous balanced mode (ABM) (determined from the Link-Station Role of XID Sender field), having a point-to-point configuration, the support required is:

<u>Commands</u>	<u>Responses</u>
I-frames	-
RR	RR
RNR	RNR
Reject	Reject
SABME	UA
Disconnect	DM
Test	Test
XID	XID
-	Frame Reject

Note 1: All commands and responses are transmitted and received in two-octet format (extended control field).

Note 2: Frame Reject is not required to be transmitted; receive capability is required.

- 24 bits 0-1, reserved
bit 2, SDLC initialization mode options:
0 SIM and RIM not supported
1 SIM and RIM supported
- bits 3-7, reserved
- 25-26 Reserved
- 27 bit 0, reserved
bits 1-7, maximum number of I-frames that can be received by the XID sender before an acknowledgment is sent, with an implied modulus for the send and receive sequence counts--less than 8 implies a modulus of 8, 8 or greater implies a modulus of 128
- 28(=n) Reserved
- n+1-p Control vectors, as described in "Control Vectors" on page B-10
Note: The following control vectors may be included:
X'0E' Network Name control vector: type X'F4', network-qualified CP name (always present; the network identifier is always used, i.e., valid lengths of the CP name are 3 to 17 bytes with an imbedded period)
X'0E' Network Name control vector: type X'F7', local name of the ALS at the XID sender (always present)
X'10' Product Set ID control vector (always present)
Note: When included in XID, the product set ID is limited to 60 bytes or less in length.
X'22' XID Negotiation Error control vector (conditionally present: present when an error during XID negotiation is detected; more than one may be present)

REQUEST/RESPONSE UNITS

BIND; PLU-->SLU, Exp; SC (BIND SESSION)

BIND is sent from a primary LU to a secondary LU to activate a session between the LUs. The secondary LU uses the BIND parameters to help determine whether it will respond positively or negatively to BIND.

- 0 X'31' request code
- 1 bits 0-3, format: 0000 (only value defined)
bits 4-7, type:
0000 negotiable (only value defined for LU 6.2)
0001 nonnegotiable
- 2 FM profile:
X'02' FM profile 2
X'03' FM profile 3
X'04' FM profile 4
X'07' FM profile 7
X'12' FM profile 18
X'13' FM profile 19 (only value defined for LU 6.2)
- 3 TS profile:
X'02' TS profile 2

BIND

X'03' TS profile 3
 X'04' TS profile 4
 X'07' TS profile 7 (only value defined for LU 6.2)

FM Usage—Primary LU Protocols for FM Data

- 4
- bit 0, chaining use selection:
 - 0 only single-RU chains allowed from primary LU half-session
 - 1 multiple-RU chains allowed from primary LU half-session (only value defined for LU 6.2)
 - bit 1, request control mode selection:
 - 0 immediate request mode (only value defined for LU 6.2)
 - 1 delayed request mode
 - bits 2-3, chain response protocol used by primary LU half-session for FMD requests; chains from primary will ask for:
 - 00 no response
 - 01 exception response
 - 10 definite response
 - 11 definite or exception response (only value defined for LU 6.2)
 - bit 4, 2-phase commit for sync point (reserved if any TS profile other than 4):
 - 0 2-phase commit not supported
 - 1 2-phase commit supported
 - bit 5, reserved
 - bit 6, compression indicator (reserved for LU 6.2):
 - 0 compression will not be used on requests from primary
 - 1 compression may be used
 - bit 7, send End Bracket indicator:
 - 0 primary will not send EB (only value defined for LU 6.2)
 - 1 primary may send EB

FM Usage—Secondary LU Protocols for FM Data

- 5
- bit 0, chaining use selection:
 - 0 only single-RU chains allowed from secondary LU half-session
 - 1 multiple-RU chains allowed from secondary LU half-session (only value defined for LU 6.2)
 - bit 1, request control mode selection:
 - 0 immediate request mode (only value defined for LU 6.2)
 - 1 delayed request mode
 - bits 2-3, chain response protocol used by secondary LU half-session for FMD requests; chains from secondary will ask for:
 - 00 no response
 - 01 exception response
 - 10 definite response
 - 11 definite or exception response (only value defined for LU 6.2)
 - bit 4, 2-phase commit for sync point (reserved if any TS profile other than 4):
 - 0 2-phase commit not supported
 - 1 2-phase commit supported
 - bit 5, reserved
 - bit 6, compression indicator (reserved for LU 6.2):
 - 0 compression will not be used on requests from secondary
 - 1 compression may be used
 - bit 7, send End Bracket indicator:
 - 0 secondary will not send EB (only value defined for LU 6.2)
 - 1 secondary may send EB

FM Usage—Common LU Protocols

- 6
- bit 0, whole-BIUs required indicator:
 - 0 the sending node supports receipt of segments on this session
 - 1 the sending node does not support receipt of segments on this session; the maximum sent-RU size specified in bytes 10 and 11 of BIND and RSP(BIND) are negotiated so that BIUs on this session are not segmented when sent to a node requiring whole BIUs
 - bit 1, FM header usage:
 - 0 FM headers not allowed
 - 1 FM headers allowed (only value defined for LU 6.2)
 - bit 2, brackets usage and reset state:
 - 0 brackets not used if neither primary nor secondary will send EB, i.e., if byte 4, bit 7 = 0 and byte 5, bit 7 = 0; brackets are used and bracket state managers' reset states are INB (1) if either primary or secondary, or both, may send EB, i.e., if byte 4, bit 7 = 1 or byte 5, bit 7 = 1; or (2) if FM profile 19 is specified (only value defined for LU 6.2)
 - 0 brackets are used and bracket state managers' reset states are INB
 - 1 brackets are used and bracket state managers' reset states are BETB
 - bit 3, bracket termination rule selection (reserved if brackets not used, i.e., if byte 6, bit 2 = 0, byte 4, bit 7 = 0, and byte 5, bit 7 = 0; and if FM profile is not 19):
 - 0 Rule 2 (unconditional termination) will be used during this session
 - 1 Rule 1 (conditional termination) will be used during this session (only value defined for LU 6.2)
 - bit 4, alternate code set allowed indicator:

- 0 alternate code set will not be used
- 1 alternate code set may be used
- bit 5, sequence number availability for sync point resynchronization (reserved if any TS profile other than 4 is used):
 - 0 sequence numbers not available
 - 1 sequence numbers available

Note: Sequence numbers are transaction processing program sequence numbers from the previous activation of the session with the same session name; they are associated with the last acknowledged requests and any pending requests to commit a unit of work. If no previous activation existed, the numbers are 0, and this bit is set to 0.
- bit 6, BIS sent (reserved for TS profiles other than 4):
 - 0 BIS not sent
 - 1 BIS sent
- bit 7, BIND queuing indicator:
 - 0 BIND cannot be queued (held, pending resource availability, thus delaying the BIND response)
 - 1 BIND sender allows the BIND receiver to queue the BIND for an indefinite period, thus delaying the sending of the BIND response

Note: BIND sender may provide a timer or operator interface to send UNBIND if session-activation time exceeds BIND sender's implementation-defined limits. BIND queuing is terminated by sending UNBIND to the BIND receiver.
- 7 bits 0-1, normal-flow send/receive mode selection:
 - 00 full-duplex
 - 01 half-duplex contention
 - 10 half-duplex flip-flop (only value defined for LU 6.2)
 - 11 reserved
- bit 2, recovery responsibility (reserved if normal flow send/receive mode is FDX, i.e., if byte 7, bits 0-1 = 00):
 - 0 contention loser responsible for recovery (see byte 7, bit 3 for specification of which half-session is the contention loser)
 - 1 symmetric responsibility for recovery (only value defined for LU 6.2)
- bit 3, contention winner/loser (reserved if normal flow send/receive mode is FDX, i.e., if byte 7, bits 0-1 = 00; or if the normal flow send/receive mode is HDX-FF, brackets are not used, FM profile is not 19, and symmetric responsibility for recovery is used, i.e., if byte 7, bits 0-1 = 10, byte 4, bit 7 = 0, byte 5, bit 7 = 0, byte 6, bit 2 = 0, and byte 7, bit 2 = 1):
 - 0 secondary is contention winner and primary is contention loser
 - 1 primary is contention winner and secondary is contention loser

Note: Contention winner is also brackets first speaker if brackets are used.
- bits 4-5, alternate code processing identifier (reserved unless Alternate Code Set Allowed indicator (byte 6, bit 4) is 1):
 - 00 process alternate code FMD RUs as ASCII-7
 - 01 process alternate code FMD RUs as ASCII-8 (only value defined for LU 6.2)

Note: When the Alternate Code Processing Identifier indicator is set to the value 01, the entire FMD request RU is to be translated using the transforms defined by the ANSI X3.26 Hollerith Card Code.
- bit 6, reserved
- bit 7, half-duplex flip-flop reset states (reserved unless (1) normal-flow send/receive mode is half-duplex flip-flop (byte 7, bits 0-1 = 10) and (2) brackets are not used or bracket state manager's reset state is INB (byte 6, bit 2 = 0)):
 - 0 HDX-FF reset state is RECEIVE for the primary and SEND for the secondary (e.g., the secondary sends normal-flow requests first after session activation)
 - 1 HDX-FF reset state is SEND for the primary and RECEIVE for the secondary (e.g., the primary sends normal-flow requests first after session activation) (only value defined for LU 6.2)
- TS Usage**
- 8 bit 0, staging indicator for session-level pacing of the secondary-to-primary normal flow:
 - 0 the secondary send window size (byte 8, bits 2-7) and the primary receive window size (byte 13, bits 2-7) are for one-stage pacing (The secondary send window size is always equal to the primary receive window size.)
 - 1 the secondary send window size (byte 8, bits 2-7) and the primary receive window size (byte 13, bits 2-7) are for two-stage pacing

Note: The meanings of 0 and 1 are reversed from the corresponding staging indicator for the primary-to-secondary normal flow.
- bit 1, reserved
- bits 2-7, secondary send window size, in binary, for session-level pacing
- 9 bits 0-1, reserved
- bits 2-7, secondary receive window size, in binary, for session-level pacing
- 10 Maximum RU size sent on the normal flow by the secondary half-session: if bit 0 is set to 0, no maximum is specified and the remaining bits 1-7 are ignored; if bit 0 is set to 1, bit 0 is set to 1, and the byte is interpreted as X'ab' = a*2**b (Notice that, by definition, a≥8 and therefore X'ab' is a normalized floating point representation.) See Figure B-1 on page B-8 for all possible values.

BIND

- 11 Maximum RU size sent on the normal flow by the primary half-session: identical encoding as described for byte 10
- 12 bit 0, staging indicator for session-level pacing of the primary-to-secondary normal flow:
 - 0 the primary send window size (byte 12, bits 2-7) and the secondary receive window size (byte 9, bits 2-7) are for two-stage pacing
 - 1 the primary send window size (byte 12, bits 2-7) and the secondary receive window size (byte 9, bits 2-7) are for one-stage pacing (The primary send window size is always equal to the secondary receive window size.)

Note: The meanings of 0 and 1 are reversed from the corresponding staging indicator for the secondary-to-primary normal flow (byte 8, bit 0).

 - bit 1, reserved
 - bits 2-7, primary send window size, in binary, for session-level pacing
- 13 bits 0-1, reserved
- bits 2-7, primary receive window size, in binary, for session-level pacing
- PS Profile
- 14 bit 0, PS Usage field format:
 - 0 basic format (only value defined)
 - bits 1-7, LU type:
 - 0000000 LU type 0
 - 0000001 LU type 1
 - 0000010 LU type 2
 - 0000011 LU type 3
 - 0000100 LU type 4
 - 0000110 LU type 6
 - 0000111 LU type 7

PS Usage characteristics

Note: The following format for bytes 15-25 applies only to LU 6.2; for information on PS usage bytes 15-25 for other than LU 6.2 (indicated by byte 14, bits 1-7 = 0000110 and byte 15 = 00000010), see SNA—Sessions Between Logical Units.
- 15 LU-6 level:
 - X'02' Level 2 (i.e., LU 6.2)
- 16-22 Reserved
- 23 bits 0-2, retired
- bit 3, conversation-level security support:
 - 0 Access Security Information field will not be accepted on incoming FMH-5s
 - 1 Access Security Information field will be accepted on incoming FMH-5s
- bits 4-5, reserved
- bit 6, already-verified function support:
 - 0 Already Verified indicator will not be accepted on incoming FMH-5s
 - 1 Already Verified indicator will be accepted on incoming FMH-5s
- bit 7, reserved
- 24 bit 0, reserved
- bits 1-2, synchronization level:
 - 01 confirm is supported
 - 10 confirm, sync point, and backout are supported
- bit 3, reserved
- bits 4-5, responsibility for session reinitiation (reserved unless bit 6 of this byte is set to 0):
 - 00 operator controlled
 - 01 primary half-session will reinitiate
 - 10 secondary half-session will reinitiate
 - 11 either may reinitiate
- bit 6, parallel session support for LU-LU pair:
 - 0 not supported
 - 1 supported
- bit 7, Change Number of Sessions GDS variable flow support (set to 1 if byte 24, bit 6 = 1):
 - 0 not supported
 - 1 supported
- 25 Reserved
- End of PS Usage Field
- 26-k Cryptography Options
- 26 bits 0-1, private cryptography options (reserved for LU 6.2):
 - 00 no private cryptography supported
 - 01 private cryptography supported: the session cryptography key and cryptography protocols are privately supplied by the end user
- bits 2-3, session-level cryptography options:
 - 00 no session-level cryptography supported
 - 01 session-level selective cryptography supported; all cryptography key management is supported by the SSCP and LU; exchange (via +RSP(BIND)) and verification (via CRV) of the cryptography session-seed value is supported by the LUs for the session; all FMD requests carrying ED are enciphered/deciphered by the TCs
 - 10 reserved
 - 11 session-level mandatory cryptography supported; all cryptography key management is supported by the SSCP and LU; exchange (via +RSP(BIND)) and verification (via CRV)

of the cryptography session-seed value is supported by the LUs for the session; all FMD requests are enciphered/deciphered by TC

Note: Only values 00 and 11 are defined for LU 6.2.

bits 4-7, session-level cryptography options field length:

X'0' no session-level cryptography specified; following additional cryptography options fields (bytes 27-k) omitted

X'9' session-level cryptography specified; additional options follow in next nine bytes

- 27 bits 0-1, session cryptography key encipherment method:
00 session cryptography key enciphered under SLU master cryptography key using a seed value of 0 (only value defined)
- bits 2-4, reserved
- bits 5-7, cryptography cipher method:
000 block chaining with seed and cipher text feedback, using the Data Encryption Standard (DES) algorithm (only value defined)
- 28-k Session cryptography key enciphered under secondary LU master cryptography key; an eight-byte value that, when deciphered, yields the session cryptography key used for enciphering and deciphering FMD requests
- k+1-m Primary LU Name Field (always present)
- k+1 Length of primary LU name (values 1 to 17 are valid)
Note: Value 0 is retired.
- k+2-m Primary LU name or, if the secondary LU issued the INIT-SELF (or INIT-OTHER), INIT-SELF, the uninterpreted name as carried in that RU (and also in CDINIT for a cross-domain session)
- m+1-n User Data Field
Length of user data
Note: X'00' = no User Data field present; if unstructured user data present, values 1 to 65 are valid.
- m+2-n User data
- m+2 User data key:
X'00' structured subfields follow (only value defined for LU 6.2)
Note: Individual structured subfields may be omitted entirely. When present, they appear in ascending subfield-number order.
-X'00' first byte of unstructured user data.
- For unstructured user data:
- m+3-n Remainder of unstructured user data
- For structured user data:
- m+3-n Structured subfields (For detailed definitions, see SNA Reference Summary.)
- n+1-p User Request Correlation Field (present only if carried in INIT from SLU, or if Secondary LU name field or control vectors are included)
- n+1 Length of user request correlation (URC) field (values 0 to 12 are valid)
Note: X'00' = no URC present.
- n+2-p URC: LU-defined identifier (present only if carried in INIT from SLU)
- p+1-r Secondary LU Name Field (present only for negotiable BINDs)
- p+1 Length of secondary LU name (values 1 to 17 are valid)
Note: Value 0 is retired.
- p+2-r Secondary LU name

Note 1: The length of the BIND RU cannot exceed 256.

Note 2: If the last byte of a format 0 request is a length field and that field is 0, that byte may be omitted from the BIND request.

		Mantissa (a)							
Exponent (b)	8	9	A (10)	B (11)	C (12)	D (13)	E (14)	F (15)	
0	8	9	10	11	12	13	14	15	
1	16	18	20	22	24	26	28	30	
2	32	36	40	44	48	52	56	60	
3	64	72	80	88	96	104	112	120	
4	128	144	160	176	192	208	224	240	
5	256	288	320	352	384	416	448	480	
6	512	576	640	704	768	832	896	960	
7	1024	1152	1280	1408	1536	1664	1792	1920	
8	2048	2304	2560	2816	3072	3328	3584	3840	
9	4096	4608	5120	5632	6144	6656	7168	7680	
A (10)	8192	9216	10240	11264	12288	13312	14336	15360	
B (11)	16384	18432	20480	22528	24576	26624	28672	30720	
C (12)	32768	36864	40960	45056	49152	53248	57344	61440	
D (13)	65536	73728	81920	90112	98304	106496	114688	122880	
E (14)	131072	147456	163840	180224	196608	212992	229376	245760	
F (15)	262144	294912	327680	360448	393216	425984	458752	491520	

Note: A value of X'ab' in byte 10 or byte 11 of BIND represents $a \cdot 2^{**}b$. For example, X'C5' represents (in decimal) $12 \cdot 2^{**}5 = 384$.

Figure B-1. RU Sizes Corresponding to Values X'ab' in BIND

UNBIND; LU-->LU, Exp; SC (UNBIND SESSION)

UNBIND is sent to deactivate an active session between the two LUs.

0 X'32' request code
 1 UNBIND type (for UNBIND types X'00' through X'06' and X'80' through X'FF', the session is ended when the response is received; for UNBIND types X'07' through X'7F', the session is ended immediately):
 X'01' normal end of session
 X'02' BIND forthcoming; retain the node resources allocated to this session, if possible
 X'06' invalid session parameters: the BIND negotiation has failed because the primary half-session cannot support parameters specified by the secondary
 X'07' virtual route inoperative: the virtual route used by the LU-LU session has become inoperative, thus forcing the deactivation of the identified LU-LU session
 X'08' route extension inoperative: the route extension used by the LU-LU session has become inoperative, thus forcing the deactivation of the identified LU-LU session
 X'09' hierarchical reset: the identified LU-LU session is being deactivated because of a +RSP((ACTPU | ACTLU), Cold)
 X'0A' SSCP gone: the identified LU-LU session had to be deactivated because of a forced deactivation of the SSCP-PU or SSCP-LU session (e.g., DACTPU, DACTLU, or DISCONTACT was received)
 X'0B' virtual route deactivated: the identified LU-LU session had to be deactivated because of a forced deactivation of the virtual route being used by the LU-LU session
 X'0C' LU failure--unrecoverable: the identified LU-LU session had to be deactivated because of an abnormal termination of the PLU or SLU; recovery from the failure was not possible
 X'0E' LU failure--recoverable: the identified LU-LU session had to be deactivated because of an abnormal termination of one of the LUs of the session; recovery from the failure may be possible
 X'0F' cleanup: the node sending UNBIND is resetting its half-session before receiving the response from the partner node
 X'11' gateway node cleanup: a gateway node is cleaning up the session because a gateway SSCP has directed the gateway node (via NOTIFY) to deactivate the session (e.g., a session setup error or session takedown failure has occurred)
 X'FE' session failure: the session has failed for a reason specified by the associated sense data

- For UNBIND Type=X'FE', the Sense Data field is included; otherwise, it is omitted.

2-5 Sense data: same value as generated at the time the error was originally detected (e.g., for a negative response, receive check, or EXR)

Note 1: Extensions to the UNBIND (unrecognized after byte 5) are ignored by receivers at the current level of SNA.

RSP(BIND); SLU-->PLU, Exp; SC

A +RSP(BIND) carries the session parameters as indicated by the SLU or by intermediate nodes along the session path.

- A short (1-byte) response may be sent for a nonnegotiable BIND request that specifies no session-level cryptography.
- A cryptography response (bytes 0-k) may be sent for a nonnegotiable BIND request that specifies session-level cryptography.
- A negotiable response (bytes 0-r) may be sent for a negotiable BIND request.

0 X'31' request code
 1 bits 0-3, format: 0000 (only value defined)
 bits 4-7, type:
 0000 negotiable (only value defined for LU 6.2)
 0001 nonnegotiable
 2-25 Bytes 2-25 of the BIND request: for a negotiable response, the negotiated values may differ for a cryptography response, the values are the same as those received in the BIND request
 26-k Cryptography Options (see Note 3)
 26 bits 0-1, private cryptography options: for a nonnegotiable response, same value as received in the request, if present
 bits 2-3, session-level cryptography options: for a nonnegotiable response and an LU 6.2 response, same value returned as received in the request, if present
 bits 4-7, session-level cryptography options field length: same value (Bytes 27-k are omitted if this length field is omitted or set to 0.)
 27 bits 0-1, session cryptography key encipherment method: same value returned as received in the request, if present
 bits 2-4, reserved
 bits 5-7, cryptography cipher method: same value returned as received

RSP(BIND)

28-k An eight-byte implementation-chosen, nonzero, pseudo random session-seed cryptography value enciphered under the session cryptography key, if session-level cryptography is specified; otherwise, omitted

k+1(=m) Retired: set to 0 by implementations at the current level of SNA

m+1 Length of user data

m+2-n User data: for a negotiable response, the user data may differ from that received on the BIND request

n+1 Length of URC

n+2-p URC as received on the BIND request

p+1(=r) Retired: set to 0 by implementations at the current level of SNA

Note 1: On a response, if the last byte of a response is a length field and that field is 0, that byte may be dropped from the response. This applies also to byte 26 (where the count occupies only bits 4-7) if bits 0-3 are also 0—the entire byte may be dropped if no bytes follow.

Note 2: In negotiable BIND responses, reserved fields in the BIND are set by the SLU to binary 0's in the RSP(BIND); any fields at the end of the BIND (after byte r) that are not recognized by the SLU are discarded and not returned in the RSP(BIND).

Note 3: The first byte of the Cryptography Options field (byte 26) is returned on the response for a nonnegotiable BIND only when session-level cryptography was specified in the BIND. Byte 26 is always present in any negotiable response if not truncated as allowed in Note 1. In all cases, however, the remaining bytes of the Cryptography Options field (bytes 27-k) are present only if session-level cryptography was specified in the BIND.

CONTROL VECTORS

Product Set ID (X'10')

0 Key: X'10'

1 Length (n-1), in binary, of Vector Data field

2-n Vector Data

2 Retired

3-n Network product identifier: one or two Product Identifier (X'11') MS common subvectors, as described in SNA Reference Summary, one for each hardware product and software product in the implementation of the PU

Network Name (X'0E')

0 Key: X'0E'

1 Length (n-1), in binary, of Vector Data field

2-n Vector Data

2 Network name type:
X'F4' CP name
X'F7' link station name (not network-qualified)

3-n Network-qualified name: a 1- to 17-byte name consisting of an optional qualifier concatenated to a 1- to 8-byte type-A symbol-string name; when present, the qualifier contains a 1- to 8-byte type-A symbol-string network identifier concatenated with a period (when the qualifier is not present, the period is omitted). The network-qualified name appears, for example, as follows: NETID.NAME, with no imbedded blanks and with optional (but not significant) trailing blanks.

XID Negotiation Error (X'22')

0 Key: X'22'

1 Length (n-1), in binary, of Vector Data field

2-n Vector Data

2-3 Error byte offset: the binary offset (zero-origin in the XID information field) of the first byte of the field in error

4(=n) Error bit offset: the binary offset (zero-origin in the byte pointed at in the Error Byte Offset field) of the first bit of the field in error

SENSE DATA

The sense data included with an EXCEPTION REQUEST (EXR), a negative response, or an UNBIND request, is a four-byte field (see Figure B-2 on page B-11) that includes a one-byte category value, a one-byte modifier value, and two bytes of sense code specific information, whose format is defined along with the sense code definition, below.

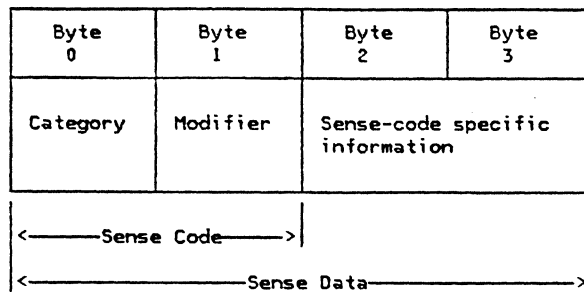


Figure B-2. Sense Data Format

Together, the category byte 0, the modifier byte 1, and the sense code specific bytes 2 and 3 hold the sense data defined for the exception condition that has occurred.

The following categories are defined; all others are reserved:

<u>VALUE</u>	<u>CATEGORY</u>
X'08'	Request Reject
X'10'	Request Error
X'20'	State Error
X'40'	Request Header (RH) Usage Error
X'60'	Path Error

In earlier versions of SNA, user data (as well as implementation-specific data) generally could be carried in bytes 2-3 for all categories. This is no longer the case. Bytes 2-3 are used generally only for SNA-defined conditions for nonzero categories; exceptions for implementation-specific use are documented in the appropriate product publications.

The sense codes for the other categories are discussed below.

REQUEST REJECT (CATEGORY CODE = X'08')

This category indicates that the request was delivered to the intended component and was understood and supported, but not executed.

Category and modifier (in hexadecimal):

0801 Resource Not Available: The LU, PU, link station, or link specified in an RU is not available.

0812 Insufficient Resource: Receiver cannot act on the request because of a temporary lack of resources.

Bytes 2 and 3 may contain the following sense code specific information:

0000 No specific code applies.

0007 Insufficient resources are available for LU address allocation.

000D Insufficient buffers exist to activate a session.

0815 Function Active: A request to activate a network element or procedure was received, but the element or procedure was already active.

Bytes 2 and 3 following the sense code contain sense code specific information:

0004 A BIND was received from an T2.1 node when the session is already active; i.e., the LFSID is in use. The receiver rejects the BIND.

RSP(BIND)

0835 Invalid Parameter (with Pointer Only): The request contained a fixed- or variable-length field whose contents are invalid or not supported by the NAU that received the request.

nnnn Bytes 2 and 3 contain a two-byte binary count that indexes (zero-origin) the first byte of the fixed- or variable-length field having invalid contents.

REQUEST ERROR (CATEGORY CODE = X'10')

This category indicates that the RU was delivered to the intended NAU component, but could not be interpreted or processed. This condition represents a mismatch of NAU capabilities.

Category and modifier (in hexadecimal):

1002 RU Length Error: The request RU was too long or too short.

RH USAGE ERROR (CATEGORY CODE = X'40')

This category indicates that the value of a field or combination of fields in the RH violates architectural rules or previously selected BIND options. These errors prevent delivery of the request to the intended component and are independent of the current states of the session. They may result from the failure of the sender to enforce session rules. Detection by the receiver of each of these errors is optional.

Category and modifier (in hexadecimal):

4005 Incomplete RH: Transmission shorter than full TH-RH.

PATH ERROR (CATEGORY CODE = X'80')

This category indicates that the request could not be delivered to the intended receiver, because of a path outage, an invalid sequence of activation requests, or one of the listed path information unit (PIU) errors. Some PIU errors fall into other categories; for example, sequence number errors are sense code category X'20'. A path error received while the session is active generally indicates that the path to the session partner has been lost.

Category and modifier (in hexadecimal):

8004 Unrecognized Destination: A node in the path has no routing information for the destination specified either by the SLU name in a BIND request or by the TH.

8005 No Session: No half-session is active in the receiving end node for the indicated origination-destination pair, or no boundary function session connector is active for the origin-destination pair in a node providing the boundary function. A session activation request is needed.

8006 Invalid FID: Invalid FID for the receiving node.

8007 Segmenting Error: First BIU segment had less than 10 bytes; or mapping field sequencing error, such as first, last, middle; or segmenting not supported and MPF not set to 11.

Bytes 2 and 3 following the sense code contain sense code specific information:

0000 No specific code applies.

0001 The node does not support receipt of segments, and a mapping field value other than OIS was received. Sent in UNBIND.

800B Incomplete TH: Transmission received was shorter than a TH.

800F The address combination is invalid.

Bytes 2 and 3 following the sense code contain sense code specific information:

0000 The (DAF',OAF') (FID2) combination or the LSID (FID3) specified an invalid type of session, for example, a PU-LU combination.

0001 The FID2 ODAI setting in a received BIND is incorrect; the BIND is rejected.

APPENDIX C. TERMINOLOGY: ACRONYMS AND ABBREVIATIONS

Replace this page with foldout page C-1 from the back of the book.

Replace this page with foldout page C-3 from the back of the book.

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APPENDIX C. TERMINOLOGY: ACRONYMS AND ABBREVIATIONS

ABM	asynchronous balanced mode	ESI	Exchange State indicators
ABME	asynchronous balanced mode extended	EXR	EXCEPTION REQUEST
ALS	adjacent link station	ELLC	enhanced logical link control
ASM	address space manager		
		FID2	format identification type 2
BIU	basic information unit	FRMR	Frame Reject (SDLC response)
BLU	basic link unit	FSM	finite-state machine
BTU	basic transmission unit		
		IPL	initial program load
CP	control point		
		LFSID	local-form session identifier
CS	configuration services	LU	logical unit
DAF'	Destination Address field prime	MPF	Mapping field
DISC	Disconnect (SDLC command)		
DLC	data link control	NAU	network addressable unit
DM	Disconnected Mode (SDLC response)	NOF	node operator facility
		NRM	normal response mode

NRME	normal response mode extended	SABME	Set Asynchronous Balanced Mode Extended (SDLC command)
OAF'	Origin Address field prime	SDLC	Synchronous Data Link Control
ODAI	OAF'-DAF' Assignor indicator	SIDH	session identifier high
PC	path control	SIDL	session identifier low
PIU	path information unit	SLU	secondary logical unit
PLU	primary logical unit	SNA	Systems Network Architecture
QLLC	qualified logical link control	SNRM	Set Normal Response Mode (SDLC command)
RD	Request Disconnect (SDLC response)	SNRME	Set Normal Response Mode Extended (SDLC command)
RH	request/response header	SS	session services
RIM	Request Initialization Mode (SDLC response)	TH	transmission header
RNR	Receive Not Ready (SDLC command/response)	T2.1	type 2.1
RR	Receive Ready (SDLC command/response)	UA	Unnumbered Acknowledgment (SDLC response)
RU	request/response unit	XID	Exchange Identification (SDLC command/response)
SABM	Set Asynchronous Balanced Mode (SDLC command)	XID3	XID format 3

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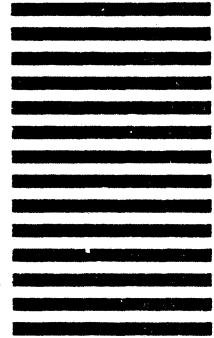
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