The X.25 1984/1988 DTE/DCE and DTE/DTE Interface

Architecture Reference

SC30-3409-1

IBM

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Portions of CCITT Recommendation X.25 (Melbourne, November 1988) from the CCITT Ninth Plenary Assembly 'BLUE BOOK' Volume IX - Fascicle VIII.3 are reprinted in this manual with special authorization of the International Telecommunications Union (ITU).

Abstract

SC30-3409, THE X.25 1984/1988 DTE/DCE and DTE/DTE INTERFACE ARCHITECTURE REFERENCE describes the protocols, formats and procedures for the three layers - physical, data link and packet - of the X.25 DTE/DCE and DTE/DTE interfaces, as well as the logical link control(s) employed by IBM SNA X.25 DTEs on both SNA-to-SNA and SNA-to-non_SNA connections.

Preface

This manual describes the elements, including optional user facilities, of CCITT Recommendation X.25 - INTERFACE BETWEEN DATA TERMINAL EQUIPMENT (DTE) AND DATA CIRCUIT TERMINATING EQUIPMENT (DCE) FOR TERMINALS OPERATING IN THE PACKET MODE ON PUBLIC DATA NETWORKS (Geneva, 1976; amended Geneva, 1980; Malaga-Torremolinos, 1984; and Melbourne, 1988) - that are applicable to IBM SNA network nodes that can attach to X.25-based Packet-Switched Data Networks (PSDNs). It is based on the version of CCITT Recommendation X.25 adopted by the IXth Plenary Assembly in 1988 as published in the 'Blue Books'.

Excerpts from CCITT Recommendation X.25 (Melbourne, November 1988), including sections 1.1 - 1.2, 2.1 - 2.5, 3.1 - 3.5, 4.1 - 4.6, 5.1 - 6.6, 5.7.2, 6.1 - 6.28, 7.1 - 7.3, Annex A, Annex B, Annex C, Annex D, Annex E, Annex F and Annex G are reprinted in this manual.

IBM SNA data terminal equipment (DTEs) that use the X.25 recommendation to interface to PSDN data circuit-terminating equipment (DCEs) are referred to in this document as IBM SNA X.25 DTEs. Elements of CCITT Recommendation X.25 (1988) are selected by IBM to support three basic categories of connections:

a. SNA-to-SNA:

   connections between SNA X.25 DTEs, either via direct attachment; or via virtual calls or permanent virtual circuits, or both, through intervening packet-switched data network(s); are accommodated.

b. SNA-to-non_SNA:

   connections between SNA X.25 DTEs and non-SNA X.25 DTEs, either via direct attachment; or via virtual calls or permanent virtual circuits, or both, through intervening packet-switched data network(s); are accommodated.

c. OSI.N_connections

   between X.25 Packet-Mode DTEs, either via direct attachment; or, via virtual calls or permanent virtual circuits, or both, through intervening packet-switched data network(s); are accommodated.

The DTE/DCE and DTE/DTE interfaces for SNA-to-SNA connections, SNA-to-non_SNA connections and OSI.N_connections differ only at the packet layer; therefore, the definitions and descriptions of the physical layer and the data link layer apply equally to all three types of connections.

Information in this manual must not be construed as describing any specific IBM product (machine or program) or service. Neither can it be construed to mean that all or any specific IBM products necessarily provide only, or all of, the X.25 DTE/DCE or DTE/DTE interface functions described herein.

In addition, note that the ELLC, QLLC and PSH Protocols defined in this manual describe existing implementations of end-to-end control functions that are required above the X.25 DTE/DCE Interface. Further end-to-end controls applicable for use with X.25-based network services may be implemented as requirements become more clearly identified. Readers are cautioned to refer to appropriate IBM product description and operation manuals for information regarding the availability and characteristics of X.25 DTE/DCE interface functions supported by specific IBM products.

The reader is assumed to be conversant with both CCITT Recommendation X.25 and SNA. A list of applicable references is included in a companion General Information Manual, GA27-3761, to help the less informed reader to understand these subjects.

CCITT Recommendation X.25 (Melbourne, November 1988), like it's predecessor (Malaga-Torremolinos, October, 1984), defines an interface between customer data terminal equipment (DTE) and data circuit-terminating equipment (DCE). It is designed to facilitate the attachment of DTEs to packet-switched data networks (PSDNs). The definition includes three independent elements:

1. Physical Layer - the mechanical, electrical, functional and procedural characteristics to activate, maintain and deactivate physical communication links between DTEs and DCEs.
2. Data Link Layer - the link access procedure for the interchange of data across communication links between DTEs and DCEs.
3. Packet Layer - the packet formats and control procedures for the exchange of control information or user data, or both, between DTEs and DCEs.

Other international standards explicitly or implicitly reflected in this specification include:

- CCITT Recommendation X.1 - International User Classes of Service in Public Data Networks and Integrated Services Digital Networks (ISDN);
- CCITT Recommendation X.2 - International Data Transmission Services and Optional User Facilities in Public Data Networks;
- CCITT Recommendation X.21 - Interface between Terminal Equipment (DTE) and Data Circuit-Terminating Equipment (DCE) for Synchronous Operation on Public Data Networks;
- CCITT Recommendation X.21_bis - Use on Public Data Networks of Data Terminal Equipment (DTE) which are Designed for Interfacing to Synchronous V-Series Modems;
- CCITT Recommendation X.31 - Support of Packet Mode Terminal Equipment by an ISDN;
- CCITT Recommendation X.32 - Interface between Data Terminal Equipment (DTE) and Data Circuit-Terminating Equipment (DCE) for terminals operating in a packet mode and accessing a packet switched public data network through a public switched telephone network or an integrated services digital network or a circuit switched public data network;
- CCITT Recommendation X.96 - Call Progress Signals in Public Data Networks;
- CCITT Recommendation X.110 - Routing Principles for International Public Data Services through Switched Public Data Networks of the Same Type;

- CCITT Recommendation X.121 - International Numbering Plan for Public Data Networks;
- CCITT Recommendation X.200 - Reference Model of Open Systems Interconnection for CCITT Applications;
- CCITT Recommendation X.213 - Network Service Definition for Open Systems Interconnection for CCITT Applications;
- CCITT Recommendation X.223 - Use of X.25 Packet Layer Protocol to provide the OSI Connection Mode Network Service;
- CCITT Recommendation X.244 - Procedure for the Exchange of Protocol Identification During Virtual Call Establishment on Packet-Switched Public Data Networks;
- CCITT Recommendation X.301 - Description of the General Arrangements for Call Control within a Subnetwork and between Subnetworks for the Provision of Data Transmission Services;
- ISO-8348 - Open Systems Interconnection (OSI) - Network Service Definition;
- ISO-7776 - Description of the X.25 LAPB-compatible DTE Data Link Procedures;
- ISO-7498 - Information processing systems - Open Systems Interconnection - Basic Reference Model;
- ISO-8208 - X.25 Packet Layer Protocol for Data Terminal Equipment;
- ISO-8878 - Information Processing Systems - Data Communications - Use of X.25 to provide the OSI connection-mode network service;
- ISO-8880-2 - Information Processing Systems - Data Communications - Support of the connection-mode network service; and,
- ANS X3.100 - Interface between Data Terminal Equipment (DTE) and Data Circuit-Terminating Equipment (DCE) for Operation with Packet-Switched Data Networks (PSDN), or between two DTEs, by Dedicated Circuit.

This document supports communication between a DTE and a DCE or between two DTEs without an intervening network. Since one of those DTEs will be acting as a DCE, the term DTE/DTE can be substituted for the term DTE/DCE in the following paragraphs.

A companion document, GA27-3761, The X.25_1984/1988 Interface for Attaching IBM SNA Nodes to Packet-Switched Data Networks - General Information Manual, describes the elements of CCITT Recommendation X.25_1984/1988 selected for implementation in IBM SNA X.25_1988 DTEs that adhere to Systems Network Architecture (SNA).

CCITT Recommendation X.25_1988 focuses on a description of the DTE/DCE interface functions from the perspective of DCEs. This manual focuses on the same interface from the perspective of DTEs. Thus, many instances occur where the term DTE or DCE is replaced by the word station(s). Other substantive differences between the two interface descriptions and SC30-3409-0 are identified by symbols in the left margin of this document. Text included herein that:

- is essentially the same as that contained in CCITT Recommendation X.25 (Melbourne, November 1988) and that contained in SC30-3409-0 is unmarked:

> - is essentially the same as that contained in CCITT Recommendation
> X.25 (Melbourne, November 1988) but differs substantially from that
> contained in SC30-3409-0 is identified by greater than symbols (>) in
> the left margin of this document;

\+ - differs substantially from that contained in CCITT Recommendation
\+ X.25 (Melbourne, November 1988) and that contained in SC30-3409-0 is
\+ identified by plus signs (+) in the left margin of this document;

s - is extracted from ISO-7776, ISO-8208 or ANS x3.100 for elaboration or
s clarification and is identified by the letter s in the left margin of this
s document.

\+ DCE operation as described in CCITT Recommendation X.25_(1988) is retained here for comparative purposes.

Notes:

1. The bit/byte numbering used throughout this specification is consistent with the numbering used in CCITT Recommendation X.25 and may, therefore, differ from that with which the reader may be more familiar.
2. Network specific interface requirements, that deviate from the
   \+ interpretation of CCITT Recommendation X.25 (Melbourne,
   \+ November 1988), ISO 7776, ISO 8208 or ANS x3.100 reflected in this document, may be considered by IBM SNA X.25 Product Managers on an individual basis, in making technical and business judgements regarding possible justification for the support of such deviation(s). Network specific requirements are not defined in this manual.

\+ This manual complies with, and is patterned after, the version of CCITT Recom-
\+ mendation X.25 adopted by the IXth Plenary Assembly at Melbourne and sub-
\+ sequently published in the 'Blue Book.' It also complies with requirements set
\+ forth in ANS-X3.100, ISO-7776, ISO 8208, and ISO-8878 for the provision of
\+ Network Layer services in Open Systems. It is composed of nine chapters and
several appendixes, as follows:

Chapter 1 - DTE/DCE Interface Characteristics

specifies the physical layer interface used between IBM SNA X.25 DTEs and their associated DCEs.

Chapter 2 - Link Access Procedure Across the DTE/DCE Interface

specifies the data link layer interface used for the interchange of data via communication links between IBM SNA X.25 DTEs and their associated DCEs.

Chapter 3 - Description of the Packet Layer DTE/DCE Interface

describes the packet layer procedures used to exchange control information and user data at the X.25 DTE/DCE interface.

Chapter 4 - Procedures for Virtual Circuit Services describes the procedures used for virtual call and permanent virtual circuit services.

Chapter 5 - Packet Formats

specifies the formats for packets exchanged between IBM SNA X.25 DTEs and their associated DCEs.

Chapter 6 - Procedures for Optional User Facilities (Packet Layer)

describes the optional packet layer user facilities and specifies procedures for their selection and use.

Chapter 7 - Formats for Facility Fields and Registration Fields

specifies the formats for facility fields and registration fields for optional user facilities.

Chapter 8 - Logical Link Control (LLC) on SNA-to-SNA Connections

introduces the adjacent node protocols (logical link controls) employed by IBM SNA X.25 DTEs in PSDN environments to perform SNA adjacent node physical services.

Chapter 9 - Other System Considerations

describes some other considerations for the use of IBM SNA X.25 DTEs in Packet-Switched Data Network environments.

Appendix A - Logical Channel Ranges

defines the ranges of logical channels used for virtual calls and permanent virtual circuits.

Appendix B - Packet Layer DTE/DCE Interface State Diagrams

defines the packet layer state transitions at the X.25 DTE/DCE interface.

Appendix C - Packet Layer DCE Actions

describes the actions taken by DCEs on receipt of packets in a given state of the packet layer X.25 DTE/DCE interface as perceived by DCEs.

Appendix D - DCE Time-outs and DTE Time-limits

defines packet layer DCE time-outs and DTE time-limits.

Appendix E - Network Generated Diagnostic Codes

specifies the diagnostic codes generated by DCEs employing CCITT Recommendation X.25 for CLEAR INDICATION, RESET INDICATION, RESTART INDICATION and DIAGNOSTIC packets.

Appendix F - On-Line Registration Facility Applicability

defines applicability of the on-line registration facilities to other facilities.

Appendix G - CCITT-Specified_DTE Facilities describes CCITT-Specified_DTE facilities that may be passed unchanged between communicating DTEs to support end-to-end signalling required by the OSI Network Service.

Appendix H - SNA-to-SNA Diagnostic Codes

specifies the diagnostic codes generated by IBM SNA X.25 DTEs for CLEAR REQUEST, RESET REQUEST and RESTART REQUEST packets on SNA-to-SNA connections.

Appendix I - Packet Layer DTE Actions

describes the actions taken by IBM SNA X.25 DTEs on receipt of packets in a given state of the packet layer of the X.25 DTE/DCE interface as perceived by DTEs.

Appendix J - Physical Services Headers

describes the Physical Services Header (PSH) used on SNA-to-SNA connections to an IBM 5973 Network Interface Adapter (NIA).

Appendix K - SNA-to-Non_SNA Architectural Considerations

describes some architectural considerations for SNA-to-non SNA connections.

Appendix L - LAPB SLP Finite State Machines

describes the actions taken by IBM SNA X.25 DTEs upon occurrence of events in the various states of the data link layer SLP interface.

Appendix M - Description of the Enhanced Logical Link Control (ELLC) Procedures

describes the actions taken by IBM SNA X.25 DTEs upon occurrence of events in the various states of the interface for ELLC.

Appendix N - X.25_1980/1984/1988 Compatibility Considerations

describes limitations that may be imposed on the use of X.25_1984 and X.25_1988 functions and formats for compatibility with specific X.25 DTE/DCE Interface implementations that comply with CCITT Recommendation X.25_1980.

Appendix O - Description of the BNN_Qualified Logical Link Control - (QLLC) Procedures

describes the protocols, formats and procedures employed by IBM SNA X.25_1988 DTE Boundary Network Nodes for Qualified Logical Control on SNA-to-SNA connections.

Appendix V - Information on Addresses in Call Set-up and Clearing Packets

describes the two components a DTE address may include: a main address and a complementary address as defined in CCITT Recommendation X.25 (Melbourne, 1988).

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X.25 DTE/DCE and DTE/DTE Interface

Appendixes

X.25 DTE/DCE and DTE/DTE Interface

Chapter 1. DTE/DCE Interface Characteristics (Physical Layer)

Administrations may offer one or more of the interfaces specified below. The exact use of the relevant points in these specifications is detailed below.

1.1 CCITT Recommendation X.21

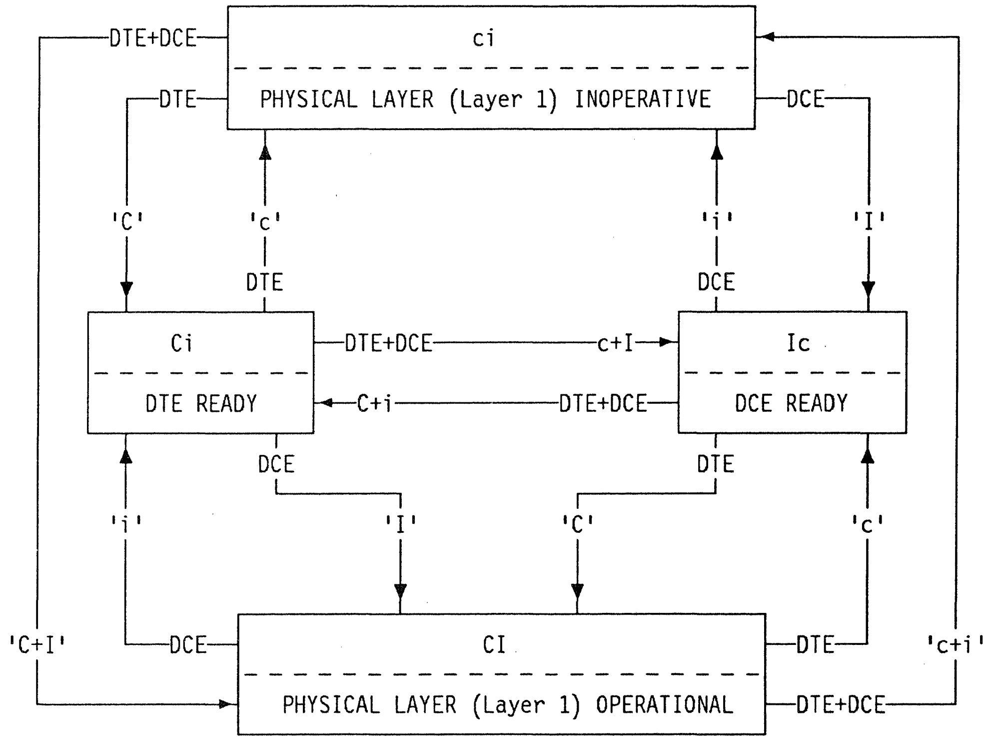
1.1.1 DTE/DCE Physical Interface Elements

The DTE/DCE physical interface elements shall be according to §§ 2.1 through 2.5 of CCITT Recommendation X.21.

1.1.2 Procedures for Entering Operational Phases

The procedures for entering operational phases shall be as described in § 5.2 of CCITT Recommendation X.21. The data exchanged on circuits T and R when the interface is in states 13S, 13R and 13 of Figure A-3/X.21 of CCITT Recommendation X.21 will be as described in subsequent sections of this specification.

The not ready states given in § 2.5 of Recommendation X.21 are considered to be non-operational states and may be considered by the higher layers to be out-of-order states (see "Effects of the Physical and Data Link Layer on the Packet Layer" on page 4-23).




```
Legend:
        'C' signifies c = ON signal
        'c' signifies c = OFF signal
        'I' signifies i = ON signal
        'i' signifies i = OFF signal
```

Figure 1-1. Physical Layer (Layer 1) Initialization. X.21 Non-Switched

1.1.3 Failure Detection and Test Loops

The failure detection principles shall be according to § 2.6 of CCITT Recommendation X.21. In addition, i = OFF may be signalled due to momentary transmission failures. Higher layers may delay for several seconds before considering the interface to be out-of-order.

The definitions of test loops and the principles of maintenance testing using the test loops are provided in CCITT Recommendation X.150.

A description of the test loops and the procedures for their use is given in § 7 of CCITT Recommendation X.21.

Automatic activation by a DTE of a Test Loop 2 in the DCE at the remote terminal is not possible. However, some Administrations may permit the DTE to control the equivalent of a Test Loop 2, at the local DSE (Data Switching Equipment), to verify the operation of the leased line or subscriber line and all or part of the DCE or line terminating equipment. Control of the loop, if provided, may be either manual or automatic, as described in CCITT Recommendation X.150 and X.21, respectively.

1.1.4 Signal element timing

Signal element timing shall be in accordance with § 2.6.3 of CCITT Recommendation X.21.

1.2 Recommendation X.21_bis Interface

1.2.1 DTE/DCE Physical Interface Elements

The DTE/DCE physical interface elements shall be according to § 1.2 of CCITT Recommendation X.21_bis.

1.2.2 Operational Phases

When circuit 107 is in the ON condition, and circuits 105, 106, 108 and 109, if provided, are in the ON condition, data exchange on circuits 103 and 104 will be as described in subsequent sections of this specification.

When circuit 107 is in the OFF condition, or any of circuits 105, 106, 108 or 109, if provided, are in the OFF condition, this is considered to be in a non-operational state, and may be considered by the higher layers to be in an out-of-order state (see "Effects of the Physical and Data Link Layer on the Packet Layer" on page 4-23).

1.2.3 Failure Detection and Test Loops

The failure detection principles, the description of test loops and the procedures for their use shall be according to §§ 3.1 through 3.3 of CCITT Recommendation X.21_bis. In addition, circuits 106 and 109 may enter the OFF condition due to momentary transmission failures. Higher layers may delay for several seconds before considering the interface to be out-of-order.

Automatic activation by a DTE of Test Loop 2 in the DCE at the remote terminal is not possible. However, some Administrations may permit the DTE to control the equivalent of a Test Loop 2, at the local DSE to verify the operation of the leased line or subscriber line and all or part of the DCE or line terminating equipment. Control of the loop, if provided, may be either manual or automatic as described in CCITT Recommendation X.150 and X.21_bis, respectively.

1.2.4 Signal Element Timing

Signal element timing shall be in accordance with § 3.4 of CCITT Recommendation X.21_bis.

1.3 V-Series Interface

General operation with V-series modems is as described in "Recommendation X.21_bis Interface" above. However, for specific details, particularly related to failure detection principles, loop testing, and the use of circuits 107, 109, 113 and 114, refer to the appropriate CCITT V-series Recommendations.

The delay between 105-ON and 106-ON (when these circuits are present) will be more than 10 ms and less than 1 sec. In addition, circuits 106 or 109 may enter the OFF condition due to momentary transmission failures or modem retraining.

Higher layers may delay for several seconds before considering the interface to be out-of-order.

1.4 Recommendation X.31 Interface

1.4.1 DTE/DCE Physical Interface

The DTE/DCE physical interface shall coincide with the R reference point between the DTE and the Terminal Adaptor (TA). The purpose of the TA is to allow the operation of a DTE over an ISDN. The functions of such a TA when accessing a packet switched data transmission service through a semi-permanent ISDN connection (i.e., a non switched B-channel) are described in § 7 of Recommendation X.31.

Notes:

1. This type of access is considered a dedicated access to a public switched data transmission service. Non dedicated (or demand) access to a public switched data transmission service is defined in Recommendations X.32 and X.31.
2. The DTE and the TA functions may be implemented in the same piece of equipment in the case of a packet mode terminal TE1 conforming to the I-series Recommendations. In this case, this Recommendation covers layer 2 and layer 3 operation on a semi-permanent B-channel.

1.4.2 Operational Phases

The operational phases are as described in § 7 of Recommendation X.31.

1.4.3 Maintenance

The maintenance shall be made as described in § 7.6 of Recommendation X.31.

1.4.4 Synchronization

The synchronization shall be made as described in § 7 of Recommendation X.31.

1.5 Access Speeds

IBM SNA X.25 DTEs support one or more of the following CCITT recommended data transmission speeds:

2.4, 4.8, 9.6 or 48.0 Kbit/s.

Additional data transmission speeds that may be considered by specific IBM SNA X.25 DTEs include:

1.2, 19.2, 56.0 and 64.0 Kbit/s.

In order to be compatible with ANS X3.100, all Packet Switching Data Networks (PSDNs) must support the data signaling rates of 4.8 and 9.6 Kbit/s duplex.

Chapter 2. Link Access Procedure Across the DTE/DCE Interface

Basic functions of the Data Link Layer, link access procedure, for DTEs include:

- Link initialization - necessary for the DTE to begin communication in a known state;
- Flow control - to control the flow of frames between the DTE and the other station (DCE or DTE) to ensure that they are not sent more quickly than they can be received;
- Error Detection - provided in two forms,
  1. a cyclic redundancy check (CRC) using a 16-bit polynomial to detect mutilated frames,
  2. use of sequence numbers to protect against the loss of entire frames; and
- Error Recovery - which endeavors to insure correct receipt of all frames by retransmission of missing or mutilated frames.

2.1 Scope and Field of Applications

2.1.1 Introduction

The Link Access Procedure (LAPB) is described as the Data Link Layer Element and is used for data interchange between a DCE and a DTE, or between two DTEs, over a single physical circuit, or optionally over multiple physical circuits operating in user classes of service 8 to 11 inclusive as indicated in CCITT Recommendation X.1. The optional, subscription-time selectable, multiple physical circuit operation with LAPB (known as multilink operation) is required if the effects of circuit failures are not to disrupt the Packet Layer operation.

The single link procedures (SLPs), described in §§ 2.2, 2.3 and 2.4 are used for data interchange over a single physical circuit, conforming to the description given in Chapter 1, "DTE/DCE Interface Characteristics (Physical Layer)," between a DTE and a DCE or between two DTEs. When the optional multilink operation is employed, a single link procedure (SLP) is used independently on each physical circuit, and the multilink procedure (MLP) described in "Multilink Procedure - (MLP) (Subscription-time Selectable Option)" on page 2-44 is used for data interchange over these multiple parallel LAPB data links. In addition, when only a single physical circuit is employed with LAPB, agreements may be made with the Administration to use this optional multilink procedure over the one LAPB data link.

2.1.2 Terminology

The single link procedures (SLPs) use the principles and terminology of the High-Level Data Link Control (HDLC) procedures specified by the International Organization for Standardization (ISO). The multilink procedure (MLP) is based on the principles and terminology of the Multilink Control Procedures specified by ISO.

2.1.3 Media Characteristics

The transmission facility is duplex.

2.1.4 Compatibility

Station (DCE and DTE) compatibility of operation with the ISO balanced class of procedure (Class BA with options 2, 8 and Class BA with options 2, 8, 10) is achieved using the LAPB procedures described in §§ 2.3 and 2.4 of this specification. Of these classes, Class BA with options 2, 8 (LAPB modulo 8) is the basic service, and is available in all networks. Class BA with options 2, 8, 10 (LAPB modulo 128) is recognized as an optional, subscription-time selectable, extended sequence numbering service that may be available in those networks wishing to serve DTE applications having a need for modulo 128 sequence numbering.

DTE manufacturers and implementers must be aware that the procedure hereunder described as LAPB modulo 8 will be the only one available in all networks.

Likewise, a DTE may continue to use the LAP procedure described in §§ 2.2, 2.6 and 2.7 of CCITT Recommendation X.25 (in those networks supporting such a procedure), but for new DTE implementations, LAPB should be preferred.

Note:

Other possible applications are being considered by the CCITT, for example:

- two-way alternate, asynchronous response mode;
- two-way simultaneous, normal response mode; and,
- two-way alternate, normal response mode.

2.1.5 LAPB Service Selection

For those DTE/DCE connections that choose to support both the basic and extended LAPB sequence numbering services, the choice of either basic mode (modulo 8) or extended mode (modulo 128) may be made at subscription-time. The choice of the mode employed for each data link procedure is independent of all others and of the choice of mode for the corresponding Packet Layer procedures. All choices are matters for agreement for a period of time with the Administration. For those DTE/remote DTE connections that support both basic (modulo 8) and extended (modulo 128) operation, the choice is made by bilateral agreement.

2.2 Frame Structure

2.2.1 Delineation

All transmissions on an SLP are in frames conforming to one of the formats shown in Table 1 for basic (modulo 8) operation or, alternatively, one of the formats shown in Table 2 for extended (modulo 128) operation. The flag preceding the address field is defined as the opening flag. The flag following the FCS is defined as the closing flag.

2.2.2 Flag (F) Sequence

All frames shall start and end with at least one flag sequence consisting of at least one '0' bit followed by six contiguous '1' bits and one '0' bit ('01111110'). The DTE and DCE shall only send complete eight-bit flag sequences when sending multiple flag sequences (see § 2.2.11). A single flag sequence may be used as both the closing flag for one frame and the opening flag for the next frame.

Note:

IBM SNA X.25 DTEs transmit and receive bit configurations '...0111111001111110...' as sequences of multiple flag sequences; and, also receive and interpret bit configurations '...011111101111110...' as sequences of multiple flags sequences.

TABLE 1 – Frame Formats – Basic (Modulo 8) Operation

Order of Bit Transmission	12345678	12345678	12345678	16 to 1	12345678
	Flag	Address	Control	FCS	Flag
	F 01111110	A 8-bits	C 8-bits	FCS 16-bits	F 01111110

Order of Bit Transmission	12345678	12345678	12345678	123.......n	16 to 1	12345678
	Flag	Address	Control	Information	FCS	Flag
	F 01111110	A 8-bits	C 8-bits	I N-Octets[1]	FCS 16-bits	F 01111110

FCS = frame checking sequence
[1] – an Octet is an 8-bit byte.

TABLE 2 – Frame Formats – Extended (Modulo 128) Operation

Order of Bit Transmission	12345678	12345678	1 to *	16 to 1	12345678
	Flag	Address	Control	FCS	Flag
	F 01111110	A 8-bits	C *-bits	FCS 16-bits	F 01111110

Order of Bit Transmission	12345678	12345678	1 to *	123.......n	16 to 1	12345678
	Flag	Address	Control	Information	FCS	Flag
	F 01111110	A 8-bits	C *-bits	I N-Octets[1]	FCS 16-bits	F 01111110

FCS = frame checking sequence

[1] – an Octet is an 8-bit byte.

* 16 for frame formats that contain sequence numbers; 8 for frame formats that do not contain sequence numbers.

2.2.3 Address (A) Field

The A field is a single octet. The address field identifies the intended receiver of a command frame and the transmitter of a response frame. The coding of the address field is described in § 2.4.2

2.2.4 Control (C) Field

For modulo 8 (basic) operation, the control field shall consist of one octet. For modulo 128 (extended) operation, the control field shall consist of two octets for frame formats that contain sequence numbers, and one octet for frame formats that do not contain sequence numbers. The content of this field is described in § 2.3.2

2.2.5 Information (I) Field

The information field of a frame, when present, follows the control field (see § 2.2.4) and precedes the frame check sequence field (see § 2.2.7).

See §§ 2.3.4.9, 2.5.2, 2.6.4.8, 5, 8 and Appendixes J, M and O for the various codings and groupings of bits in the information field as used in this specification. The coding and grouping of bits received from a higher layer are unrestricted, except for requirements that may be imposed by the higher layer itself.

See §§ 2.3.4.9, 2.4.8.5, 2.6.4.8 and 2.7.7.5 with regard to the maximum information field length.

Note:

Frames containing other than an integral number of octets are ignored by IBM SNA X.25 DTEs at the data link layer.

2.2.6 Transparency

Transmitting stations examine the frame content between the two flag sequences including the address, control, information and FCS fields and insert a '0' bit immediately after all sequences of 5 contiguous '1' bits (including the last 5 bits of the FCS) to ensure that a flag sequence is not simulated by data on the line. Receiving stations examine the frame content and discard any '0' bit which directly follows 5 contiguous '1' bits.

2.2.7 Frame Checking Sequence (FCS) Field

The notation used to describe the FCS is based on the property of cyclic codes that a code vector such as '1000000100001' can be represented by a polynomial $P(x) = x^{12} + x^5 + 1$. The elements of an n-element code word are thus the coefficients of a polynomial of order n - 1. In this application, these coefficients can have the value '0' or '1' and the polynomial operations are performed modulo 2. The polynomial representing the content of a frame is generated using the first bit received after the frame opening flag as the coefficient of the highest order term.

The FCS is a 16-bit sequence. It shall be the ones complement of the sum (modulo 2) of:

1. the remainder of $X^{\text{'0'}}(X^{15} + X^{14} + X^{13} + \ldots + X^2 + X + 1$ divided (modulo 2) by the generator polynomial $X^{16} + X^{12} + X^5 + 1$, where '0' is the number of bits in the frame existing between, but not including, the final bit of the opening flag and the first bit of the FCS, excluding bits inserted for transparency, and
2. the remainder of the division (modulo 2) by the generator polynomial $X^{16} + X^{12} + X^5 + 1$ of the product of X^{16} by the content of the frame, existing between but not including, the final bit of the opening flag and the first bit of the FCS, excluding bits inserted for transparency.

As a typical implementation, at transmitting stations, the initial content of the register of the device computing the remainder of the division is preset to all '1's and is then modified by division by the generator polynomial (as described above) on the address, control and information fields; the ones complement of the resulting remainder is transmitted as the 16-bit FCS.

At receiving stations, the initial content of the register of the device computing the remainder is preset to all '1's. The final remainder, after multiplication by x^{16} and then division (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$ of the serial incoming protected bits and the FCS, will be '0001110100001111' (X^{15} through X^0, respectively) in the absence of transmission errors.

Note:

Examples of transmitted bit patterns by the DCE and the DTE illustrating application of the transparency mechanism and the frame check sequence to the SABM command and the UA response are given in "TRANSMITTED BIT PATTERN EXAMPLES" on page 2-6.

2.2.8 Order of Bit Transmission

Addresses, commands, responses, sequence numbers and information octets are transmitted with the low-order bit first (for example the first bit of the sequence number that is transmitted has the weight 2^0). The FCS shall be transmitted to the line commencing with the coefficient of the highest term, which is found in bit position 16 of the FCS field (see Tables 1 and 2).

Note:

In Tables 1 through 13, bit 1 is defined as the low-order bit.

2.2.8.1 TRANSMITTED BIT PATTERN EXAMPLES

(Appendix I to CCITT Recommendation X.25_1988: Examples of Data Link Layer Transmitted Bit Patterns by the DCE and the DTE).

Introduction: This section, provided for explanatory purposes, indicates the bit patterns that will exist on the physical link for some of the unnumbered frames. It is included for the purpose of furthering the understanding of the transparency mechanism and the frame check sequence implementation.

DCE Transmission

- SABM Command Frame with Address = A, P = 1

```
┌─ First bit transmitted                            Last bit transmitted ─┐
↓                                                                         ↓
0111 1110    1100 0000    1111 10[3]100    1101 1010 0011 0111    0111 1110
 Flag        Address = A   SABM(P=1)         Frame Check Sequence   Flag
```

- UA Response Frame with Address = B, F = 1

```
┌─ First bit transmitted                         Last bit transmitted ─┐
↓                                                                      ↓
0111 1110    1000 0000    1100 1110    1101 0001 1110 1010    0111 1110
 Flag        Address = B   UA(F=1)      Frame Check Sequence   Flag
```

DTE Transmission

- SABM Command Frame with Address - B, P = 1

```
┌─ First bit transmitted                         Last bit transmitted ─┐
↓                                                                      ↓
0111 1110   1000 0000   1111 10[3]100   1101 0111 110[3]11 1011   0111 1110
 Flag       Address = B  SABM(P=1)     Frame Check Sequence     Flag
```

- UA Response Frame with Address = A, F = 1

```
┌─ First bit transmitted                         Last bit transmitted ─┐
↓                                                                      ↓
0111 1110    1100 0000    1100 1110    1100 1100 0010 0110    0111 1110
 Flag        Address = A   UA(F=1)      Frame Check Sequence   Flag
```

[3] - Zero inserted for transparency

2.2.9 Invalid frames

The definition of an invalid frame is described in § 2.3.5.3.

2.2.10 Frame Abortion

Aborting a frame is performed by transmitting at least seven (7) contiguous '1' bits (with no inserted '0's).

2.2.11 Interframe Time-Fill

Interframe time-fill is accomplished by transmitting contiguous flags between frames, i.e., multiple eight-bit flag sequences (see § 2.2.2).

2.2.12 Data Link Channel States

A link channel is defined here as the means for transmission for one direction.

2.2.12.1 Active Channel State

The incoming or outgoing channel is defined to be in an active condition when the station is receiving or transmitting, respectively, a frame, an abortion sequence or interframe time-fill.

2.2.12.2 Idle Channel State

The incoming or outgoing channel is defined to be in an idle condition when the station is receiving or transmitting, respectively, a continuous '1s' state for a period of at least 15 bit times.

See § 2.3.5.5 for a description of DCE action when an idle condition exists on its incoming channel for an excessive period of time.

IBM SNA X.25 DTEs do not generate Idle Channel state as a normal sequence and those that detect the Idle Channel state may consider it either:

- as an indication that the DCE is not able to support data link set-up;
- as a simple indication that the DCE has temporarily suspended transmission; or,
- as an indication that the data link is in the disconnected phase if a flag sequence is not received within at least time Ti. Ti is defined in § 2.4.8.7.

Note:

Upon detection of the idle channel state for at least time T3, DTEs should consider the data link to be in the disconnected state. T3 is as defined in "DCE Timer T3" on page 2-36.

2.3 LAPB Elements of Procedure

2.3.1 Definition

The LAPB elements of procedure are defined in terms of actions that occur on receipt of frames at the DCE or DTE.

The elements of procedure specified below contain the selection of commands and responses relevant to the LAPB data link and system configuration described in § 2.1. Together §§ 2.2 and 2.3 form the general requirements for proper management of the access data link connecting a DCE and an IBM SNA X.25 DTE.

2.3.2 LAPB Control Field Formats and Parameters

2.3.2.1 Control (C) Field Formats

The C field contains a command or a response, and sequence numbers when applicable.

Three types of C-field formats are used to perform numbered information transfers (I format), numbered supervisory functions (S format) and unnumbered control functions (U format).

The control field formats for basic (modulo 8) operation are depicted in Table 3.

TABLE 3 – Control Field Formats – Basic (Modulo 8) Operation

Control field bits	8	7	6	5	4	3	2	1
I frame		Nr		P		Ns		0
S frame		Nr		P/F	S	S	0	1
U frame	M	M	M	P/F	M	M	1	1

Ns = transmitter send sequence number (bit 2 = low order bit).
Nr = transmitter receive sequence number (bit 6 = low order bit).
S = supervisory function bit.
M = modifier function bit.
P/F = poll (P) bit in command frames or final (F) bit in response frames (1 = Poll/Final).
P = Poll bit (1 = Poll).

The control field formats for extended (modulo 128) operation are depicted in Table 4.

TABLE 4 – Control Field Formats – Extended (Modulo 128) Operation

Control Field Bits	Octet 2		Octet 1							
	8 – – – – – – – – – – 2	1	8	7	6	5	4	3	2	1
I format	Nr	P	Ns							0
S format	Nr	P/F	X	X	X	X	S	S	0	1
U format	Single Octet Format		M	M	M	P/F	M	M	1	1

Ns = send sequence number (bit 2 of octet 1 = low order bit).
Nr = receive sequence number (bit 2 of octet 2 = low order bit).
S = supervisory function bit.
M = modifier function bit.
X = Reserved and set to '0'.
P/F = poll (P) bit in command frames or final (F) bit in response frames (1 = Poll/Final).
P = Poll bit (1 = Poll).

1. Information Transfer Format - I

   The I format is used to perform information transfers. The functions of Ns, Nr and P are independent; i.e., each I frame has an Ns, and an Nr which may or may not acknowledge additional I frames received by the DCE or DTE, and a P bit that may be set to '0' or '1'.

2. Supervisory Format - S

   The S format is used to perform data link supervisory control functions such as acknowledging I frames, requesting retransmission of I frames, and requesting temporary suspension of transmission of I frames. The functions of Nr and P/F are independent; i.e., each supervisory frame has an Nr which may or may not acknowledge additional I frames received by the DCE or DTE, and a P/F bit that may be set to '0' or '1'.

3. Unnumbered Format - U

   The U format is used to provide additional data link control functions. This format contains no sequence numbers, but does include a P/F bit that may be set to '0' or '1'. The numbered frames have the same control field length (one octet) in both basic (modulo 8) operation and extended (modulo 128) operation.

2.3.2.2 Control Field Parameters

The various parameters associated with the control field formats are described as follows:

1. Modulus - 'm'

   Each I frame is sequentially numbered and may have the value '0' through 'modulus minus one' (where "modulus" is the modulus of the sequence numbers). The modulus equals either '8' or '128' and the sequence numbers cycle through the entire range '0' to '7' or '0' to '127', inclusive, respectively.

2. Send State Variable - (Vs)

   Vs denotes the sequence number of the next in-sequence I frame to be transmitted. Vs can take on the value '0' through 'modulus minus one'. The value of Vs is incremented by one with each successive I frame transmission, but cannot exceed the Nr of the last received I or S frame by more than the maximum permissible number of outstanding I frames (k). The value of 'k' is defined in § 2.4.8.6.

3. Send Sequence Number - (Ns)

   Only I frames contain Ns, the send sequence number of transmitted frames. At the time that an in-sequence I frame is designated for transmission, the value of Ns is set equal to the value of the send state variable (Vs).

4. Receive State Variable - (Vr)

   Vr denotes the sequence number of the next in-sequence I frame expected to be received. Vr can take on the values '0' through 'modulus minus one'. The value of Vr is incremented by one upon receipt of each error free, in-sequence I frame whose Ns that is equal to the current value of Vr.

5. Receive Sequence Number - (Nr)

   All I frames and S frames contain Nr, the expected sequence number of the next received I frame. At the time that a frame of the above types is designated for transmission, the value of Nr is set equal to the current value of Vr. Nr indicates that the station transmitting the Nr has correctly received all I frames numbered up to and including 'Nr - 1'.

6. Poll/Final Bit - (P/F)

   All frames contain P/F, the Poll/Final bit. In command frames, the P/F is referred to as the Poll (P) bit. In response frames, it is referred to as the Final (F) bit.

2.3.3 Functions of the Poll/Final Bit

'P = 1' is used by the DCE or DTE to solicit (poll) a response from the DTE or DCE/remote DTE, respectively. 'F = 1' is used by the DCE or DTE to indicate the response frame transmitted by the DTE or DCE, respectively, as a result of the soliciting (poll) command.

Use of the 'P/F' bit is described in § 2.4.3.

2.3.4 Commands and Responses

For basic (modulo 8) operation, the commands and responses represented in Table 5 will be supported by the DCE and the DTE.

For extended (modulo 128) operation, the commands and responses represented in Table 6 will be supported by the DCE and the DTE.

For purposes of the LAPB procedures, the supervisory function bit encoding '11' and those encodings of the modifier function bits in Tables 3 and 4 not identified in Tables 5 and 6 are identified as "undefined or not implemented" command and response control fields.

The commands and responses in Tables 5 and 6 are defined in "Information (I) Command" through "Frame Reject (FRMR) Response" on page 2-15.

2.3.4.1 Information (I) Command

The function of the I command is to transfer across a data link a sequentially numbered frame containing an information field.

TABLE 5 – Commands and Responses – Basic (Modulo 8) Operation

Format	Commands	Responses	Encoding Bits 8	7	6	5	4	3	2	1
Information transfer	I		Nr			P	Ns			0
Supervisory	RR	RR	Nr			P/F	0	0	0	1
	RNR	RNR	Nr			P/F	0	1	0	1
(See Note)	REJ	REJ	Nr			P/F	1	0	0	1
Unnumbered	SABM		0	0	1	P	1	1	1	1
	DISC		0	1	0	P	0	0	1	1
		DM	0	0	0	F	1	1	1	1
		UA	0	1	1	F	0	0	1	1
		FRMR	1	0	0	F	0	1	1	1

DISC = Disconnect
DM = Disconnected Mode
FRMR = Frame Reject
I = Information
REJ = Reject
RNR = Receive Not Ready
RR = Receive Ready
SABM = Set Asynchronous Balanced Mode
UA = Unnumbered Acknowledgement

Note: IBM SNA X.25 DTEs transmit Unnumbered commands with 'P = 1' and Information command frames with 'P = 0'

TABLE 6 — Commands and Responses — Extended (Modulo 128) Operation

			Octet 2								Octet 1							
			8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1
FMT	CMND	RESP	Encoding															
I	I		Nr							P	Ns							0
S	RR	RR	Nr							P/F	0	0	0	0	0	0	0	1
	RNR	RNR	Nr							P/F	0	0	0	0	0	1	0	1
	REJ	REJ	Nr							P/F	0	0	0	0	1	0	0	1
U	SABME		Single Octet Format								0	1	1	P	1	1	1	1
	DISC										0	1	0	P	0	0	1	1
		DM									0	0	0	F	1	1	1	1
		UA									0	1	1	F	0	0	1	1
		FRMR									1	0	0	F	0	1	1	1

CMND = Command
DISC = Disconnect
DM = Disconnected Mode
FMT = Format
FRMR = Frame Reject
I = Information
REJ = Reject
RESP = Response
RNR = Receive Not Ready
RR = Receive Ready
SABM = Set Asynchronous Balanced Mode
UA = Unnumbered Acknowledgement

Note: IBM SNA X.25 DTEs transmit Unnumbered commands with 'P = 1' and Information command frames with 'P = 0'

2.3.4.2 Receive Ready (RR) Command and Response

The RR supervisory frame is used by the DCE or the DTE to:

- indicate it is ready to receive an I frame; and,
- acknowledge previously received I frames numbered up to and including 'Nr - 1'.

An RR frame may be used to indicate the clearance of a busy condition that was reported by the earlier transmission of RNR frame by that same station (DCE or DTE). In addition to indicating the DCE or DTE status, the RR command with 'P = 1' may be used by the DCE or DTE to ask for the status of the DTE or DCE/remote DTE, respectively.

2.3.4.3 Receive Not Ready (RNR) Command and Response

The RNR supervisory frame is used by the DCE or DTE to indicate a busy condition; i.e., temporary inability to accept additional incoming I frames. I-frames numbered up to and including 'Nr - 1' are acknowledged. I frame Nr and subsequent I frames received, if any, are not acknowledged; the acceptance status of these I-frames is indicated in subsequent exchanges.

In addition to indicating the DCE or DTE status, the RNR command with 'P = 1' may be used by the DCE or DTE to ask for the status of the DTE or DCE/remote DTE, respectively.

Upon receipt of an RNR command or response IBM SNA X.25 DTEs start Query Timer, Tn, if it is not running. If Query Timer, Tn, then expires prior to the receipt of a UA, RR, REJ or SABM, IBM SNA X.25 DTEs perform the retransmission procedure described in § 2.4.8.1 before declaring the data link (station) to be inoperative and reporting the condition to a higher layer.

Note:

If unacknowledged frames are purged, by the DTE or DCE, as a result of sending or receiving an SABM or UA, notification must be given to a higher layer so that the DTE/DCE packet layer interface can be restarted to protect the integrity of the system when ELLC recovery is not being employed.

2.3.4.4 Reject (REJ) Command and Response

The REJ supervisory frame is used by the DCE or DTE to request transmission of I frames starting with the frame numbered Nr. I frames numbered 'Nr - 1' and below are acknowledged. Additional I frames pending initial transmission may be transmitted following the retransmitted I frame(s).

Only one REJ exception condition for a given direction of information transfer may be established at any time. The REJ exception condition is cleared (reset) upon receipt of an I frame with an Ns equal to the Nr of the REJ frame.

An REJ frame may be used to indicate the clearance of a busy condition that was reported by the earlier transmission of an RNR frame by that same station (DCE or DTE). In addition to indicating the DCE or DTE status, the REJ command with 'P = 1' may be used by the DCE or DTE to ask for the status of the DTE or DCE/remote DTE, respectively.

2.3.4.5 Set Asynchronous Balanced Mode (SABM/SABME) Command

The SABM unnumbered command is used to place the addressed DCE or DTE in an asynchronous balanced mode (ABM) information transfer phase where all command/response control fields will be one octet in length.

The SABME unnumbered command is used to place the addressed DCE or DTE in an asynchronous balanced mode (ABM) information transfer phase where numbered command/response (I and S frame) control fields will be two octets in length, and unnumbered command/response control fields will be one octet in length. No information field is permitted with the SABM or SABME command. The transmission of a SABM/SABME command indicates the clearance of a busy condition that was reported by the earlier transmission of an RNR frame by that same station (DCE or DTE). The DCE or DTE confirms acceptance of the SABM or SABME (modulo 8 (basic) operation or modulo 128 (extended) operation) command by the transmission at the first opportunity of a UA response. Upon acceptance of a this command, the DCE or DTE send state variable Vs and receive state variable Vr are set equal to '0'. IBM SNA X.25 DTEs always transmit this command with 'P = 1'.

Previously transmitted I frames that are unacknowledged when this command is acted upon remain unacknowledged (see Waiting for Acknowledgement in § 2.4.5.9). It is the responsibility of a higher layer (e.g., Packet Layer or MLP) to recover from the possible loss of the contents (e.g., packets) of such I frames.

Notes:

1. For DTE/DCE connections, the mode of operation of a data link (basic (modulo 8) or extended (modulo 128)) may be determined at subscription time. For DTE/DTE connections, the mode of operation of the data link (basic (modulo 8)) or extended ((modulo 128)) shall be determined by bilateral agreement.
2. If unacknowledged frames are purged, by the DTE or DCE, as a result of sending or receiving an SABM/SABME or UA, notification must be given to a higher layer so that the DTE/DCE packet layer interface can be restarted to protect the integrity of the system when ELLC recovery is not being employed.

2.3.4.6 Disconnect (DISC) Command

The DISC unnumbered command is used to terminate the mode previously set. It is used to inform the DCE or DTE receiving the DISC command that the DTE or DCE/remote DTE sending the DISC command is suspending operation. No information field is permitted with DISC commands. Prior to taking action on the DISC command, the DCE or DTE receiving the DISC command confirms the acceptance of the DISC command by the transmission of a UA response. The DTE or DCE sending the DISC command enters the disconnected phase when it receives the acknowledging UA response. IBM SNA X.25 DTEs always transmit DISC commands with 'P = 1'.

Previously transmitted I frames that are unacknowledged when the DISC command is acted upon remain unacknowledged (see Waiting for Acknowledgement in § 2.4.5.9). It is the responsibility of a higher layer (e.g., Packet Layer or MLP) to recover from the possible loss of the contents (e.g., packets) of such I frames.

Note:

If unacknowledged frames are purged, by the DTE or DCE, as a result of sending or receiving an SABM/SABME or UA, notification must be given to a higher layer so that the DTE/DCE or DTE/remote DTE packet layer interface can be restarted to protect the integrity of the system.

2.3.4.7 Unnumbered Acknowledgement (UA) Response

The UA unnumbered response is used by the DCE or DTE to acknowledge receipt and acceptance of the mode-setting commands. Received mode-setting commands are not acted upon until the UA response is transmitted. The transmission of a UA response indicates clearance of a busy condition that was reported by the earlier transmission of an RNR frame by that same station (DCE or DTE). No information field is permitted with the UA response.

2.3.4.8 Disconnected Mode (DM) Response

The DM unnumbered response is used to report a status where the DCE or DTE is logically disconnected from the data link, and is in the disconnected phase. The DM response may be sent to indicate that the DCE or DTE has entered the disconnected phase without benefit of having received a DISC command, or, if sent in response to the reception of a mode-setting command, is sent to inform the DTE or DCE that the DCE or DTE, respectively, is still in the disconnected phase and cannot act upon the set-mode command. No information field is permitted with the DM response.

A DCE or DTE in a disconnected phase will monitor received commands and will:

- react to an SABM/SABME command as described in § 2.4.4 below; and,
- respond with a DM response with 'F = 1' to any other command received with 'P = 1'.

2.3.4.9 Frame Reject (FRMR) Response

The FRMR unnumbered response is used by the DCE or DTE to report an error condition not recoverable by retransmission of the identical frame; i.e., at least one of the following conditions, which result from the receipt of a valid frame:

- the receipt of a command or response control field that is undefined or not implemented;
- the receipt of an I frame with an information field which exceeds the maximum established length;
- the receipt of an invalid Nr; or,
- receipt of a frame with an information field which is not permitted or the receipt of a supervisory or unnumbered frame with an incorrect length.

An undefined or not implemented control field is any of the control field encodings that are not identified in Tables 5 or 6.

A valid Nr must be within the range from the lowest send sequence number Ns of the still unacknowledged frame(s) to the current DCE or DTE send state variable, Vs, included (or to the current internal variable 'x' if the DCE or DTE is in the timer recovery condition as described in § 2.4.5.9).

An information field which immediately follows the control field, and consists of 3 or 5 octets (modulo 8 (basic) operation or modulo 128 (extended) operation, respectively), is returned with this response and provides the reason for the FRMR response. These formats are given in Tables 7 and 8.

TABLE 7 – FRMR Information Field Format – Basic (Modulo 8) Operation

I-field bits 1 2 3 4 5 6 7 8	9	10 11 12	13	14 15 16	17	18	19	20	21	22	23	24
Rejected Frame Control Field	0	Vs	C/R	Vr	W	X	Y	Z	0	0	0	0

With reference to Table 7:

'Rejected frame control field' is the control field of the received frame that caused the frame reject.

'Vs' is the current value of Vs at the DCE or DTE reporting the rejection condition (bit 10 = low-order bit).

'C/R' set to '1' indicates the rejected frame was a response. C/R set to '0' indicates the rejected frame was a command.

'Vr' is the current value of Vr at the DCE or DTE reporting the rejection condition (bit 14 = low-order bit).

'W=1' indicates that the control field received and returned in bits 1 through 8 was considered invalid or not implemented.

'X=1' indicates that the control field received and returned in bits 1 through 8 was considered invalid because the frame contained an information field which is not permitted with this frame or is a supervisory or unnumbered frame with incorrect length. 'W=1' is required in conjunction with this bit.

'Y=1' indicates that the information field received exceeded the maximum established capacity.

'Z=1' indicates that the control field received and returned in bits 1 through 8 contained an invalid Nr.

Bits 9 and 21 to 24 shall be set to '0'.

TABLE 8 – FRMR Information Field Format – Extended (Modulo 128) Operation

I-field bits 1 - - - - - - - - - - 16	17	18 - - 24	25	26 - - 32	33	34	35	36	37	38	39	40
Rejected Frame Control Field	0	Vs	C/R	Vr	W	X	Y	Z	0	0	0	0

With reference to Table 8:

'Rejected frame control field' is the control field of the received frame that caused the frame reject. When the rejected frame is an unnumbered frame, the control field of the rejected frame is positioned in bit positions 1-8, with 9-16 set to '0'.

'Vs' is the current value of Vs at the DCE or DTE reporting the rejection condition (bit 18 = low-order bit).

'C/R' set to '1' indicates the rejected frame was a response. C/R set to '0' indicates the rejected frame was a command.

'Vr' is the current value of Vr at the DCE or DTE reporting the rejection condition (bit 26 = low-order bit).

'W=1' indicates that the control field received and returned in bits 1 through 16 was considered invalid or not implemented.

'X=1' indicates that the control field received and returned in bits 1 through 16 was considered invalid because the frame contained an information field which is not permitted with this frame or is a supervisory or unnumbered frame with incorrect length. 'W=1' is required in conjunction with this bit.

'Y=1' indicates that the information field received exceeded the maximum established capacity.

'Z=1' indicates that the control field received and returned in bits 1 through 16 contained an invalid Nr.

Bits 17 and 37 to 40 shall be set to '0'.

2.3.5 Exception Condition Reporting and Recovery

The error recovery procedures which are available to effect recovery following the detection/occurrence of an exception condition at the Data Link Layer are described in "Busy Condition" through "Excessive Idle Channel State Condition on Incoming Channel" on page 2-20. Exception conditions described include situations which may occur as the result of transmission errors, DCE or DTE malfunctions or abnormal operational situations.

2.3.5.1 Busy Condition

The busy condition results when a DCE or DTE is temporarily unable to continue to receive I frames due to internal constraints (e.g., receive buffering limitations). In this case an RNR frame is transmitted from the busy DCE or DTE. I frames pending transmission may be transmitted from the busy DCE or DTE prior to or following the RNR frame.

An indication that the busy condition has cleared is communicated by the transmission of a UA (only in response to a SABM/SABME command), RR, REJ, or SABM/SABME (modulo 8/modulo 128) frame.

Upon receipt of an RNR frame from the DCE/remote DTE, the DTE shall discontinue further transmission of I frames and wait for an indication from the DCE/remote DTE that the busy condition has been cleared. If the DTE has I frames to send, it shall start a time-out function (Timer Tn) when it receives the RNR frame, or if I frames become available to send while in the busy condition, the DTE shall start Timer Tn when the first I frame becomes available. If Timer Tn runs out before an indication of busy clearance is received, the DTE shall send a supervisory command frame with the P bit set to '1' to solicit the status of the DCE/remote DTE. The response received with the F bit set to '1' shall report the busy/non-busy status of the DCE/remote DTE. The DTE shall repeatedly solicit status in this manner until either a non-busy response is received or it is determined that the data link layer should return information regarding the status of the information frames to higher layer for subsequent disposition.

2.3.5.2 Ns Sequence Error

The information field of all I frames received whose Ns does not equal the current value of Vr will be discarded.

An Ns sequence error exception condition occurs in the receiver when an I frame received contains an Ns which is not equal to the current value of Vr at the receiver. The receiver does not acknowledge (increment its Vr) the I frame causing the sequence error, or any I frame which may follow, until an I frame with Ns equal to Vr is received.

A DCE or DTE which receives one or more valid I frames having sequence errors or subsequent supervisory frames (RR, RNR and REJ) shall accept the control information contained in the Nr field and the P' or 'F' bit to perform link control functions; e.g., to receive acknowledgement of previously transmitted I frames and to cause the DCE or DTE to respond ('P = 1').

The means specified in §§ 2.3.5.2(2) and 2.3.5.2(3) shall be available for initiating the retransmission of lost or errored I frames following the occurrence of an Ns sequence error condition.

1. Checkpoint Recovery

   Checkpoint recovery shall be based on a checkpoint cycle. A checkpoint cycle shall begin with the transmission of a command frame with the P bit set to '1' and end either

   - with the receipt of a response frame with 'F = 1', or
   - when the reply time-out function (Timer T1) runs out.

   When the station receives the supervisory response frame with the F bit set to '1', after having transmitted an I, RR, RNR or REJ command frame with 'P = 1', it shall initiate retransmission of all unacknowledged I frames with sequence numbers less than the value of the send state variable Vs at the time the command frame with 'P = 1' was transmitted. (In the case where the supervisory frame received is a RNR response, the station shall first wait for an indication of clearance of the busy condition at the DCE/remote DTE before initiating possible retransmission.) Retransmission shall start with the lowest numbered unacknowledged I frame. I frames shall be retransmitted sequentially. New I frames may be transmitted if they become available. Such retransmission of I frames is known as checkpoint retransmission.

   When the station detects the necessity for checkpoint retransmission, the retransmission shall be started either before or concurrent with transmission of the next command frame with 'P = 1'.

   Note: The DTE and the DCE/remote DTE may each initiate a checkpointing cycle independently of the other by the transmission of a command frame with 'P = 1'. Therefore, since two independent checkpointing cycles may be in process simultaneously, the station will not initiate checkpoint retransmission upon the receipt of a command frame with 'F = 1', that is the response to a command frame with 'P = 1'.

To prevent duplicate retransmissions, checkpoint retransmission of a specific I frame (same Nr in the same numbering cycle) shall be inhibited for the current checkpoint cycle, if during the checkpoint cycle the station has previously received and acted upon a REJ frame with 'P = 0 or 1', or 'F = 0'.

Checkpoint retransmission shall also be inhibited if, after sending a command frame with 'P = 1', an acknowledgment for that frame is received before the next checkpoint occurs.

2. REJ Recovery

   The REJ frame is used by a receiving DCE or DTE to initiate a recovery (retransmission) following detection of a sequence error.

   With respect to each direction of transmission on the data link, only one "sent REJ" exception condition for a DCE or DTE, to a DTE or DCE/remote DTE, is established at a time. A "sent REJ" exception condition is cleared when the requested I frame is received.

   A DCE or DTE receiving REJ initiates sequential (re-)transmission of I frames starting with the I frame indicated by the Nr contained in the REJ frame. The retransmitted frames may contain an Nr and a 'P' bit that are updated from, and therefore different from, the ones contained in the originally transmitted I frames.

3. Time-out Recovery

   If, due to a transmission error, a station does not receive (or receives and discards) a single I frame or the last I frame(s) in a sequence of I frames, it will not detect an Ns sequence error condition and, therefore, will not transmit a REJ frame. The DTE or DCE which transmitted the unacknowledged I frame(s) shall, following the completion of a system specified time-out period (see § 2.4.5.1 and 2.4.5.9 below), take appropriate recovery action to determine at which I frame retransmission must begin. The retransmitted frame(s) may contain an Nr and a 'P' bit that is updated from, and therefore different from, the ones contained in the originally transmitted I frame(s).

   IBM SNA X.25 DTEs use the lost reply protection mechanism, described in § 2.4.3.1, after a system specified time-out period (see § 2.4.8.2), to determine at which I frame to begin retransmission.

2.3.5.3 Invalid Frame Condition

Any frame received which is invalid will be discarded, and no action is taken as the result of that frame. An invalid frame is defined as one which:

- is not properly bounded by two flags;
- in basic (modulo 8) operation, contains fewer than 32 bits between flags; in extended (modulo 128) operation, contains fewer than 40 bits between flags of frames that contain sequence numbers or 32 bits between flags of frames that do not contain sequence numbers;
- contains a Frame Check Sequence (FCS) error; or,
- contains an address other than 'A' or 'B' (for single link operation) or other than 'C' or 'D' (for multilink operation).

For those DTEs and DCEs that are octet aligned, a detection of non-octet alignment may be made at the Data Link Layer by adding a frame validity check that requires the number of bits between the opening flag and the closing flag, excluding bits inserted for transparency, to be an integral number of octets in length, or the frame is considered invalid.

Note:

IBM SNA X.25 DTEs may detect non-octet aligned frames (frames in which the number of bits between the opening flag and the closing flag, excluding bits inserted for transparency, is other than an integral number of octets in length) and consider them invalid at the Data Link layer.

2.3.5.4 Frame Rejection Condition

A frame rejection condition is established upon the receipt of an error-free frame with one of the conditions listed in § 2.3.4.9 above.

At the local station (DCE or DTE), this frame rejection exception condition is reported by an FRMR response for appropriate remote station action. Once a station has established such an exception condition, no additional I frames are accepted until the condition is reset by the remote station, except for examination of the 'P' bit. The FRMR response will be repeated at each opportunity, as specified in § 2.4.7.3, until recovery is effected by the remote station, or until the local station initiates its own recovery in case the remote station does not respond.

2.3.5.5 Excessive Idle Channel State Condition on Incoming Channel

Upon detection of an idle channel state condition (see § 2.2.12.2 above) on the incoming channel, the DCE shall wait for a period of T3 (see § 2.4.8.3 below) without taking any specific action, waiting for detection of a return to the active channel state (i.e., detection of at least one flag sequence). After the period T3, the DCE shall notify the higher-layer (e.g., the packet layer or the MLP) of the excessive idle channel state condition, but shall not take any action that would preclude the DTE from establishing the data link by normal data link set-up procedures.

Note:

Other actions to be taken by the DCE at the Data Link Layer upon expiration of period T3 is a subject for further study by the CCITT.

2.4 Description of the LAPB Procedure

The actions, frame transmissions and state transitions that result from events occurring in the various states of the X.25 DTE/DCE Data Link Layer interface as perceived by IBM SNA X.25 (1988) DTEs are formalized in Appendix L, "LAPB SLP Finite State Machines."

2.4.1 LAPB Basic and Extended Modes of Operation

In accordance with the system choice made by the DTE at subscription time, the DCE will either support modulo 8 (basic) operation or will support modulo 128 (extended) operation. Changing from basic operation to extended operation, or vice versa, in the DCE requires subscription by the DTE for the desired service, and is not supported dynamically.

Table 5 indicates the command and response control field formats used with the basic (modulo 8) service. The mode-setting command employed to initialize (set-up) or reset the basic mode

Table 6 indicates the command and response control field formats used with the extended (modulo 128) service. The mode-setting command employed to initialize (set-up) or reset the extended mode is the SABME command.

2.4.2 LAPB Procedure for Addressing

The address field identifies a frame as either a command or a response. A command frame contains the address of the DCE or DTE to which the command is being sent. A response frame contains the address of the DCE or DTE sending the frame.

In order to allow differentiation between single link operation and the optional multilink operation for diagnostic and/or maintenance reasons, different address pair encodings are assigned to data links operating with the multilink procedure compared to data links operating with the single link procedure.

Frames containing commands transferred from the DCE to the DTE will contain the address 'A' for single link operation and address 'C' for multilink operation.

Frames containing responses transferred from the DCE to the DTE will contain the address 'B' for single link operation and address 'D' for multilink operation.

Frames containing commands transferred from the DTE to the DCE will contain the address 'B' for single link operation and address 'D' for multilink operation.

Frames containing responses transferred from the DTE to the DCE will contain the address 'A' for single link operation and address 'C' for multilink operation.

These addresses are coded as follows:

	Address	8 7 6 5 4 3 2 1
Single Link Operation	'A'	0 0 0 0 0 0 1 1
	'B'	0 0 0 0 0 0 0 1
Multilink Operation	'C'	0 0 0 0 1 1 1 1
	'D'	0 0 0 0 0 1 1 1

Note:

The DCE or DTE will discard all frames received with an address other than 'A' or 'B' (single link operation), or 'C' or 'D' (multilink operation).

Note:

For DTE/DTE use (point-to-point non-switched applications), the assignment of A/B (single link operation) or C/D (multilink operation) addresses shall be made prior to initialization and should be capable of being fixed at system generation time.

The mechanism for ascertaining DTE address allocation in the case of point-to-point switched applications for both DTE/DCE cases and DTE/DTE cases is a subject for further study.

2.4.3 LAPB Procedure for Use of the P/F Bit

The DCE or DTE receiving an SABM/SABME, DISC, supervisory command or I frame with 'P = 1' will set 'F = 1' in the next response frame it transmits.

The response frame returned by the DCE or DTE to an SABM/SABME or DISC command with 'P = 1' will be a UA or DM with 'F = 1'. The response frame returned by the DCE or DTE to an I frame with 'P = 1', received during the information transfer phase, will be an RR, REJ, RNR or FRMR response with 'F = 1'. The response frame returned by the DCE or DTE to supervisory command with 'P=1', received during the information transfer phase, will be an RR, REJ, RNR or FRMR response with 'F = 1'. The response frame returned by the DCE or DTE to an I frame or a supervisory command with 'P = 1', received during the disconnected phase, will be an DM response with 'F = 1'.

The 'P' bit shall be used by the DCE or DTE in conjunction with the timer recovery condition (see § 2.4.5.9 below).

The response frame returned by IBM SNA X.25_1988 DTEs to:

- SABM/SABME or DISC command frame received with 'P = 1' will be a UA or DM response with 'F = 1';
- I frames received, in the information transfer phase, with 'P = 1' will be an RR, REJ, RNR or FRMR frame with 'F = 1';
- supervisory command frames received, in the information transfer phase, with 'P = 1' will be an RR, REJ, RNR or FRMR frame with 'F = 1'; or,
- I frame or supervisory frame received, during the disconnected phase, with 'P = 1' will be a DM frame with 'F = 1'.

The 'P' bit is also used by the IBM SNA X.25_1988 DTEs in conjunction with timer recovery conditions as described in § 2.4.5.9.

Note:

Other uses of the 'P' bit by the DCE is a subject for further study by the CCITT.

2.4.3.1 Lost Reply Protection

Transmitting stations provide a time-out function to protect against dead-lock conditions caused by the loss of responses from the remote station due to transmission errors. A timer T1 (or Tp for DTEs) may be started upon transmission of I-frames or supervisory command frames, or both, during the information transfer phase. Timer T1 (and Tp for DTEs) is also used during link set-up and disconnection as described in §§ 2.4.4.1 and 2.4.4.3, respectively.

If timer T1 (or Tp for DTEs) expires prior to receipt of an appropriate response frame from the remote station, recovery action is initiated by the local station. Transmitting stations transmit an appropriate supervisory command frame or retransmit the appropriate I-frame with 'P = 1' and restart timer T1 (or Tp for DTEs). After timer T1 expires N2 times, appropriate recovery action is initiated by the DCE.

Upon expiration of timer Tp prior to receipt of an appropriate response with 'F = 1', IBM SNA X.25 DTEs perform the retransmission procedure described in § 2.4.8.1 before declaring the data link (station) to be inoperative and reporting the condition to a higher layer.

2.4.4 LAPB Procedure for Data Link Set-Up and Disconnection

2.4.4.1 Data Link set-up

The DCE or DTE will indicate that it is able to set-up the data link by transmitting contiguous flags (active channel state).

Either the DTE or the DCE/remote DTE may initiate data link set-up. Prior to initiation of data link set-up, either the DTE or the DCE/remote DTE may initiate data link disconnection (see § 2.4.4.3) for the purpose of insuring that the DTE and the DCE/remote DTE are in the same phase (phase synchronization). The DCE or DTE may also transmit an unsolicited DM response to request the DTE or DCE/remote DTE to initiate data link set-up.

IBM SNA X.25 DTEs should always take the initiative in the data link layer initialization procedure by sending SABM/SABME with 'P = 1'. The DTE shall initiate data link set-up by transmitting an SABM/SABME command to the DCE and starting timer T1 in order to determine when too much time has elapsed waiting for a reply (see § 2.4.8.1 below). If, upon correct receipt of the SABM/SABME command, the DCE determines that it can enter the information transfer phase, it will return a UA response to the DTE, will reset its send and receive state variables Vs and Vr to zero, and will consider that the data link is set-up. If, upon correct receipt of the SABM/SABME command, the DCE determines that it cannot enter the information transfer phase, it will return a DM response to the DTE as a denial to the data link set-up initialization and consider that the data link is <u>not</u> set-up. In order to avoid misinterpretation of the DM response received, the DTE shall always send SABM/SABME with 'P = 1'. Otherwise, it is not possible to differentiate a DM response intended as a denial to data link set-up from a DM response that is issued in a separate unsolicited sense as a request for a mode-setting command (as described in § 2.4.4.4.2).

The DCE/remote DTE will initiate data link set-up by transmitting an SABM/SABME command to the DTE and starting its Timer T1 in order to determine when too much time has elapsed waiting for a reply (see § 2.4.8.1 below). If on receiving correctly the SABM/SAMBE command, the DTE can enter the information transfer phase, it shall return a UA response, set its send and receive state variables, Vs and Vr, to '0', and consider the link set-up. If, on receiving correctly the SABM/SABME command, the DTE cannot enter the information transfer phase, it shall return a DM response as a denial to the link set-up initialization and consider the link not set up. Upon reception of a UA response from the DTE, the DCE will reset its send and receive state variables Vs and Vr to zero, will stop its Timer T1, and will consider that the data link is set-up. Upon reception of a DM response from the DTE as a denial to the data link set-up initialization, the DCE will stop its Timer T1 and will consider that the data link is <u>not</u> set-up.

The DCE or DTE, having sent the SABM/SABME command, will ignore and discard any frames except an SABM/SABME or DISC command, or a UA or DM response received from the DTE or DCE/remote DTE. The receipt of an SABM/SABME or DISC command from the DTE or DCE/remote DTE will result in a collision situation that is resolved per § 2.4.4.5 below. Frames other than the UA or DM responses sent in response to a received SABM/SABME command will be sent only after the data link is set-up and if no outstanding SABM/SABME command exists.

After the DCE or DTE sends the SABM/SABME command, if a UA or DM response is not received correctly, Timer T1 will run out. The DCE or DTE will then resend the SABM/SABME command and will restart Timer T1. After transmission of the SABM/SABME command N2 times, appropriate higher layer recovery action will be initiated. The value of N2 is defined in § 2.4.8.4 below.

Upon expiration of Timer Tp prior to receipt of an appropriate response with 'F = 1', IBM SNA X.25 DTEs perform the retransmission procedure described in § 2.4.8.1 before declaring the data link (station) to be inoperative and reporting the condition to a higher layer.

2.4.4.2 Information Transfer Phase

After having transmitted a UA response to the SABM/SABME command or having received a UA response to a transmitted SABM/SABME command, the DCE or DTE will accept and transmit I and supervisory frames according to the procedures described in § 2.4.5 below.

During the information transfer phase, whenever there has been no activity on the data link for a period of time T4, it is strongly recommended that the DTE transmit an appropriate supervisory command frame with 'P = 1' to query the status of the DCE/remote DTE. Receipt of a response with 'F = 1' will indicate both the existence of a working physical link and the logical status of the responding DCE/remote DTE.

Upon receipt of an SABM/SABME command, a UA response or a DM response with 'F = 0', while in the information transfer phase, DTEs will inform the higher layer and conform to the resetting procedure described in § 2.4.7.2.

When receiving an SABM/SABME command while in the information transfer phase, DCEs will conform to the data link resetting procedure described in § 2.4.7.3 below.

2.4.4.3 Data Link Disconnection

IBM SNA X.25 DTEs shall initiate a disconnection of the data link by transmitting a DISC command with 'P = 1' to the DCE and starting timer Tp (see 2.4.8.1). Upon receipt of a UA or a DM response with 'F = 1' from the DCE/remote DTE IBM SNA X.25 DTEs stop timer Tp. On correctly receiving a DISC command in the information transfer phase, the DCE will send a UA response and enter the disconnected phase. On correctly receiving a DISC command in the disconnected phase, the DCE will send a DM response and remain in the disconnected phase. In order to avoid misinterpretation of the DM response received, IBM SNA X.25 DTEs always send the DISC command with 'P = 1'. Otherwise, it is not possible to differentiate a DM response intended to indicate that the DCE is already in the disconnected phase from a DM response that is issued in a separate unsolicited sense as a request for a mode-setting command (as described in § 2.4.4.4.2).

Upon expiration of timer Tp prior to receipt of a UA or DM response with 'F = 1', IBM SNA X.25 DTEs perform the retransmission procedure described in §

2.4.8.1 before declaring the data link (station) to be inoperative and reporting the condition to a higher layer.

The DCE/remote DTE will initiate a disconnect of the data link by transmitting a DISC command to the DTE and starting timer T1 (see § 2.4.8.1 below). Upon reception of a UA response from the DTE, the DCE will stop its timer T1 and will enter the disconnected phase. Upon reception of a DM response from the DTE as an indication that the DTE was already in the disconnected phase, the DCE will stop its Timer T1 and will enter the disconnected phase.

The DCE or DTE, having sent the DISC command, will ignore and discard any frames except an SABM/SABME or DISC command, or a UA or DM response received from the DTE or DCE. The receipt of an SABM/SABME or DISC command will result in a collision situation that is resolved per § 2.4.4.5 below.

After the DCE sends the DISC command, if a UA or DM response is not received correctly, Timer T1 will run out in the DCE. The DCE will then resend the DISC command and will restart Timer T1. After transmission of the DISC command N2 times by the DCE, appropriate higher layer recovery action will be initiated. The value of N2 is defined in § 2.4.8.4 below.

2.4.4.4 Disconnected Phase

1. A station having received a DISC command and returned a UA response, or having received a UA response to a transmitted DISC command, is in disconnected phase.

   Stations, in the disconnected phase, may initiate data link set-up. While in the disconnected phase, stations react to the receipt of SABM/SABME commands as described in § 2.4.4.1 above and transmit a DM response to a received DISC command. Upon receipt of any other command (defined, or undefined or not implemented) with 'P = 1' while in disconnected phase, the receiving station will transmit a DM response with 'F = 1'. Other frames received while in the disconnected phase will be ignored by the receiving station.

2. When a station enters the disconnected phase after detecting error conditions as listed in § 2.4.6 below, or after an internal malfunction, it may indicate this by sending a DM response rather than a DISC command. In these cases, the station will transmit DM with 'F = 0' and start Timer T1 (see § 2.4.8.1 below).

   If Timer T1 runs out before the reception of an SABM/SABME or DISC command from the DTE, the station will retransmit the DM response and restart Timer T1. After transmission of the DM response N2 times, the station will remain in disconnected phase and initiate appropriate recovery actions. The value of N2 is defined in § 2.4.8.4 below.

Alternatively, after an internal malfunction, the DTE may either initiate a data link resetting procedure (see § 2.4.7 below) or disconnect the data link (see § 2.4.4.3 above) prior to initiating a data link set-up procedure (see § 2.4.4.1 above).

2.4.4.5 Collision of Unnumbered Commands

Collision situations are resolved in the following way:

- If the sent and received unnumbered commands are the same, both stations send a UA response at the earliest possible opportunity and then enter the indicated phase either:

  1. after receiving the UA response;
  2. after sending the UA response; or,
  3. after timing out waiting for a UA response, having sent a UA response.

  In the case of b) above, the station will accept a subsequent UA response to the mode-setting command it issued without causing a subsequent exception condition (unsolicited UA) if received within the time-out interval.

- If the sent and received unnumbered commands are different, both stations enter the disconnected phase and transmit a DM response at the earliest possible opportunity.

2.4.4.6 Collision of DM Response with SABM/SABME or DISC Command

When a DM response is issued by the DCE/remote DTE or DTE as an unsolicited response to request the DTE or DCE/remote DTE, respectively, to issue a mode-setting command, as described in § 2.4.4.4, a collision between the SABM/SABME or DISC command and the unsolicited DM response may occur. In order to avoid misinterpretation of the DM response received, IBM SNA X.25 DTEs always transmit SABM/SABME and DISC commands with 'P = 1'.

2.4.4.7 Collision of DM Responses

A contention situation may occur when both the DCE/remote DTE and the DTE issue a DM response to request a mode-setting command. In this case, the DTE will issue an SABM/SABME command to resolve the contention situation.

2.4.5 LAPB Procedures for Information Transfer

The procedures which apply to the transmission of I frames in each direction of transmission during the information transfer phase are described in "Sending I Frames" through "Waiting for Acknowledgement" on page 2-30.

In the following text, "number one higher" is in reference to a continuously repeated sequence series, i.e., '7' is one higher than '6' and '0' is one higher than '7' for modulo 8 series, '127' is one higher than 126 and '0' is one higher than '127' for modulo 128 series.

2.4.5.1 Sending I Frames

When a station has an I frame to transmit (i.e., an I frame not already transmitted, or having to be retransmitted as described in § 2.4.5.6 below), it will transmit it with an Ns equal to its current value of Vs and an Nr equal to its current value of Vr. At the end of transmission of the I frame, the station increments Vs by one (1).

DCEs start timer T1 if it is not running at the instant of transmission of an I-frame.

IBM SNA X.25 DTEs start timer Tp upon completion of transmission of I-frames if it is not already running. IBM SNA X.25 DTEs always send I-frames with P=0.

If the value of Vs is equal to the last value of Nr received plus 'k' (where 'k' is the maximum number of outstanding I-frames permitted - see § 2.4.8.6 below), the station will not transmit any new I frame(s), but may retransmit I frames as described in §§ 2.4.5.6 or 2.4.5.9 below.

In order to insure security of information transfer, the DTE shall not transfer any I frame if its Vs is equal the last value of Nr it has received from the DCE/remote DTE plus 7 in basic (modulo 8) operation or 127 in extended (modulo 128) operation.

When a station is in the busy condition, it may continue to transmit I frames, provided the remote station is not busy. When a station is in the frame rejection condition, it will stop transmitting I frames.

2.4.5.2 Receiving an I Frame

- When a station is not in a busy condition and receives a valid I frame whose send sequence number Ns is equal to its receive state variable Vr, the station will accept the information field of this frame, increment by one (1) its receive state variable Vr, and act as follows:
  - If the station is still not in a busy condition:
    1. If an I frame is available for transmission by the station, it may act as in § 2.4.5.1 above and acknowledge the received I frame by setting Nr in the control field of the next transmitted I frame to the current value of its receive state variable Vr. Alternatively, the station may acknowledge the received I frame by transmitting an RR frame with the Nr equal to the current value of Vr.
    2. If no I frame is available for transmission by the station, it will transmit an RR frame with Nr equal to the current value of Vr.
  - If the station is now in a busy condition, it will transmit an RNR frame with Nr equal to the value of Vr (see § 2.4.5.8).
- When the station is in a busy condition, it may ignore the information field contained in any received I frame(s).

Note:

IBM SNA X.25 DTEs treat I-frames received with zero length information fields the same as any other I-frame at the data link layer.

2.4.5.3 Reception of Invalid Frames

When a station receives an invalid frame (see § 2.3.5.3), this frame will be discarded.

2.4.5.4 Reception of Out-of-Sequence I Frames

+ When a station receives a valid I frame whose send sequence number Ns is incorrect, i.e., not equal to the current value of Vr, it will discard the information field of the I frame and transmit a REJ frame with an Nr one higher than the Ns of the last correctly received I frame. The REJ frame will be a command frame with 'P = 1' if an acknowledged transfer of the retransmission request is required; otherwise the REJ frame may be either a command or a response frame. The station will then discard the information field of all I frames received until the expected I frame is correctly received. When receiving the expected I frame, the station will then acknowledge the I frame as described in § 2.4.5.2 above. The station will use the Nr and 'P' bit information in the discarded I frames as described in § 2.3.5.2 above.

2.4.5.5 Receiving Acknowledgement

When correctly receiving an I frame or a supervisory frame (RR, RNR or REJ), even in the busy condition, a station will consider the Nr contained in this frame as an acknowledgment for all I frames it has transmitted with an Ns up to and including the received 'Nr-1'. The DCE or DTE will stop Timer T1 or Tp when it correctly receives an I frame or a supervisory frame with the Nr higher than the last received Nr (actually acknowledging some I frame(s), or an REJ frame with an Nr equal to the last received Nr.

If Timer T1 or Tp has been stopped by the receipt of an I, RR or RNR frame, and if there are outstanding I frames still unacknowledged, the station will restart Timer T1 or Tp. If Timer T1 or Tp then runs out, the station will follow the recovery procedure (see § 2.4.5.9 below) with respect to the unacknowledged I frame(s). If Timer T1 or Tp has been stopped by the receipt of an REJ frame, the station will follow the retransmission procedures in § 2.4.5.6 below.

2.4.5.6 Receiving a REJ Frame

When receiving an REJ frame, a station will set its send state variable Vs equal to the Nr of the received REJ control field. It will then transmit the corresponding I frame as soon as it is available or retransmit it in accordance with the procedures described in § 2.4.5.1 above. (Re)transmission will conform to the following procedures:

- if a station is transmitting a supervisory command or response when it receives the REJ frame, it will complete that transmission before commencing transmission of the requested I frame;
- if a station is transmitting an unnumbered command or response when it receives the REJ frame, it will ignore the request for retransmission;
- if a station is transmitting an I frame when it receives the REJ frame, it may abort the I frame transmission and commence transmission of the requested I-frame immediately after abortion;
- if a station is not transmitting any frame when the REJ frame is received, it will commence transmission of the requested I frame immediately.

In all cases, if other unacknowledged I frames had already been transmitted following the one indicated in the REJ frame, then those I frames will be retransmitted by the station following retransmission of the requested I frame. Other I frames not yet transmitted may be transmitted following the retransmitted I frame(s).

If the REJ frame was received as a command with 'P = 1', the station will transmit an RR, RNR or REJ response with 'F = 1' before transmitting or retransmitting the corresponding I frame.

2.4.5.7 Receiving an RNR Frame

* Receiving an RNR at the DTE

  After receiving an RNR frame, the DTE will stop transmission or retransmission of I frames until an RR or REJ frame is received, or until Timer Tp runs out, see § 2.3.5.1.

* Receiving an RNR at the DCE

  After receiving an RNR frame whose Nr acknowledges all frames previously transmitted, the DCE will stop Timer T1 and may then transmit an I frame, with the P bit set to 0, whose send sequence number is equal to the Nr indicated in the RNR frame, restarting Timer T1 as it does. After receiving an RNR frame whose Nr indicates a previously transmitted frame, the DCE will not transmit or retransmit any I frame, Timer T1 being already running.

In either case (DTE or DCE), if the Timer (T1 for DCEs or Tn for DTEs) runs out before receipt of a busy clearance indication, the station (DTE or DCE) will follow the procedures described in § 2.4.5.9. In any case, the station will not transmit any other I frames before receiving an RR or REJ frame or before the completion of a data link resetting procedure.

Alternatively, or if no I-frames are pending transmission, after receiving an RNR frame, the station may wait for a period of time (e.g., the length of Timer T1 for DCEs or Tn for DTEs) and then transmit a supervisory command frame (RR, RNR or REJ) with 'P = 1' and start Timer T1 (DCEs) or Tp (DTEs), in order to determine if there is any change in the receive status of the remote station. The remote station shall respond to the 'P = 1' with a supervisory response frame (RR, RNR or REJ) with 'F = 1' indicating either continuance of the busy condition (RNR) or clearance of the busy condition (RR or REJ). Upon receipt of the response, Timer T1 is stopped.

- If the response is the RR or REJ response, the busy condition is cleared and the station may transmit I frames beginning with the I frame identified by the Nr in the received response frame.
- If the response is the RNR response, the busy condition still exists, and the station will, after a period of time (e.g., the length of Timer T1), repeat the enquiry of the remote station receive status.

If Timer T1 runs out before the status response is received, the enquiry process above is repeated. If N2 attempts to get a status response fail (i.e., Timer T1 runs out N2 times), the DTE will initiate a data link resetting procedure as described in § 2.4.7.2. Under the same conditions, the DCE will initiate a data link resetting procedure as described in § 2.4.7.2 or will transmit a DM response to ask the DTE to initiate a data link set-up procedure as described in § 2.4.4.1 and enter the disconnected phase. The value of N2 is defined in § 2.4.8.4 below.

If, at any time during the enquiry process, an unsolicited RR or REJ frame is received, it will be considered to be an indication of clearance of the busy condition. Should the unsolicited RR or REJ frame be a command with 'P = 1', the appropriate response frame with 'F = 1' must be transmitted before the station may resume transmission of I frames. If Timer T1 is running, the station will wait for the non-busy response with 'F = 1' or will wait for Timer T1 to run out and then may either:

- reinitiate the enquiry process in order to realize a successful P/F bit exchange (this option is not allowed in ISO 7776); or,
- may resume transmission of I frames beginning with the I frame identified by the Nr in the received RR or REJ frame.

2.4.5.8 Station Busy Condition

When a station enters a busy condition, it will transmit an RNR frame at the earliest opportunity. The RNR frame will be a command frame with 'P = 1' if an acknowledged transfer of the busy condition indication is required; otherwise the RNR may be either a command or a response frame. While in the busy condition, the station will accept and process S frames, will accept and process the contents of the Nr fields of I frames, and will return an RNR response with 'F = 1' if it receives a supervisory command or an I command frame with 'P = 1'. To clear the busy condition, the station will transmit either an REJ frame or an RR frame, with Nr set to the current value of Vr, depending on whether or not it discarded the information field of correctly received I frame(s).

The REJ frame or the RR frame will be a command frame with 'P = 1' if an acknowledged transfer of the busy-to-non-busy transition is required; otherwise the REJ frame or the RR frame may be either a command or a response frame.

2.4.5.9 Waiting for Acknowledgement

The station maintains an internal retransmission count variable (Y) which is set to '0' when the station sends a UA response, when the station receives a UA or RNR command or response, or when the station correctly receives an I frame or supervisory frame with the Nr higher than the last received Nr (actually acknowledging some I frame(s)).

If Timer T1 (or Tp for DTEs) runs out waiting for the acknowledgment for an I frame transmitted, the station will enter the timer recovery condition, add one to the internal transmission attempt variable 'Y' and set an internal variable 'X' to the current value of Vs. The DCE will then restart timer T1, set Vs equal to the last value of Nr received and retransmit the corresponding I-frame with 'P = 1' or transmit an appropriate supervisory command frame (RR, RNR or REJ) with 'P = 1'. IBM SNA X.25 DTEs restart Timer Tp, set Vs equal to the last value of Nr received and transmit an appropriate supervisory command frame (RR, RNR or REJ) with 'P = 1'. To be in compliance with ISO 7776, DTEs must transmit an appropriate supervisory command with 'P = 1', not retransmit the corresponding I-frame.

The timer recovery condition is cleared when the station receives a valid supervisory frame with 'F = 1'.

If, while in the timer recovery condition, the station correctly receives a supervisory frame with 'F = 1' and with the Nr within the range from its current Vs to 'X' included, it will clear the timer recovery condition (including stopping Timer

T1 or Tp) and set Vs equal to the value of the received Nr, and may then resume with I frame transmission or retransmission as appropriate.

If, while in the timer recovery condition, the station correctly receives a supervisory response frame 'F = 0' or an I frame with the 'P/F' bit set to '0' or '1' and with a valid Nr (see § 2.3.4.9), it will not clear the timer recovery condition. The value of the received Nr may be used to update Vs.

If the received supervisory frame with the 'P/F' bit set to '0' is an REJ frame with a valid Nr, the DCE may either immediately initiate (re)transmission from the value of the send state variable Vs, or it may ignore the request for retransmission and wait until the supervisory frame with 'F = 1' is received before initiating (re)transmission of frames from the value identified in the Nr field of the supervisory frame with 'F = 1'. In the case of immediate retransmission, in order to prevent duplicate retransmissions following clearance of the timer recovery condition, the DCE shall inhibit the retransmission of a specific I frame (same Nr) in the same numbering cycle if the DCE has retransmitted that I frame as the result of a received REJ frame with the 'P/F' bit set to '0'.

If, while in the timer recovery condition, the DCE receives a REJ command with 'P = 1', the DCE will respond immediately with an appropriate supervisory response with 'F = 1'. The DCE may then use the value of the Nr in the REJ command to update Vs, and may either immediately begin (re)transmission from the value of Nr indicated in the REJ frame or ignore the request for retransmission and wait until the supervisory frame with 'F = 1' is received before initiating (re)transmission of I frames from the value indicated in the Nr field of the supervisory frame with 'F = 1'.

In the DCE: If Timer T1 runs out in the timer recovery condition, and no I or S frame with 'F = 0' and with a valid Nr has been received, or no REJ command with 'P = 1' and with a valid Nr has been received, the DCE will add one to its transmission attempt variable, restart Timer T1, and either retransmit the I frame with 'P = 1' or transmit an appropriate supervisory command with 'P = 1'.

In the DTE (according to ISO 7776): If Timer Tp runs out before a supervisory response frame with 'F = 1' is received, the DTE will retransmit an appropriate supervisory command frame (RR, RNR or REJ) with 'P = 1'.

If the transmission attempt variable (Y) is equal to N2 (or Np for DTEs), the station will initiate a data link resetting procedure as described in § 2.4.7.2 or the DCE will transmit a DM response to ask the DTE to initiate a data link set-up procedure as described in § 2.4.4.1 above and enter the disconnected phase. N2 (and Np for DTEs) are system parameters (see § 2.4.8.4).

Note:

Although the DCE may implement the internal variable 'X', other mechanisms exist that achieve identical functions.

IBM SNA X.25 DTEs maintain separate retry counts for Information and Supervisory frames:

1. a 'transmission count' variable - which is:
   - initialized upon completion of the data link set-up procedure and upon receipt of an Nr acknowledging some I-frame(s): and
   - incremented up to N2 times upon successive expirations of Reply Timer, Tp, while in the OPENED state, and
2. a 'poll count' variable - which is:
   - initialized upon expiration of Reply Timer, Tp, while in the OPENED state; and
   - incremented up to N2 times upon successive expirations of Reply Timer, Tp, while in the CHECKPOINTING state.

In the event that either the 'transmission count' or the 'poll count' variable exceeds the retry limit, N2, IBM SNA X.25 DTEs report the access data link failure to a higher layer.

2.4.6 LAPB Conditions for Data Link Resetting or Re-Initialization

2.4.6.1 Sending Frame Reject

When a station (DTE or DCE) receives, during the information transfer phase, a frame which is not invalid (see § 2.3.5.3) with one of the conditions listed in § 2.3.4.9 above, it will request the remote station (DCE or DTE) to initiate a data link resetting procedure by transmitting a FRMR response as described in § 2.4.7.3. (A DTE will also report the error condition to a higher layer.)

2.4.6.2 Receiving Frame Reject

When a station receives, during the information transfer phase, an FRMR response, it will initiate the data link resetting procedure as described in § 2.4.7.2. (A DTE will also report the error condition to a higher layer.)

2.4.6.3 Unsolicited UA or 'F = 1'

When a station receives, during the information transfer phase, a UA response, or an unsolicited response with 'F = 1', it will initiate the data link resetting procedure as described in § 2.4.7.2. (A DTE will also report the error condition to a higher layer.)

2.4.6.4 Unsolicited DM

When a station receives, during the information transfer phase, a DM response, it will initiate the data link set-up (initialization) procedure as described in § 2.4.4.1. (A DTE will also report the error condition to a higher layer.)

2.4.7 LAPB Procedure for Data Link Resetting

2.4.7.1 Definition

The data link resetting procedure, which is used to initialize both directions of information transfer according to the procedure described below, applies only during information transfer phase.

Either the DTE or the DCE/remote DTE may initiate the data link resetting procedure. The data link resetting procedure indicates a clearance of any existing DCE and/or DTE busy condition.

2.4.7.2 Link reset

The station (DTE or DCE/remote DTE) shall initiate a data link resetting by transmitting an SABM/SABME command to the remote station (DCE/remote DTE or DTE respectively) and starting its Timer T1. If, upon correct receipt of the SABM/SABME command, the remote station (DCE/remote DTE or DTE) determines that it can continue in the information transfer phase, it will return a UA response, reset its send and receive state variables, Vs and Vr, to '0', and remain in the information transfer phase. If, upon correct receipt of the SABM/SABME command, the remote station determines that it cannot remain in the information transfer phase, it will return a DM response denying the resetting request and enter the disconnected phase.

Upon reception of a UA response, the station will reset its send and receive state variables Vs and Vr to '0', stop its Timer T1, and remain in the information transfer phase. Upon reception of a DM response, denying the data link resetting request, the station will stop its Timer T1 and enter the disconnected phase.

The station, having sent an SABM/SABME command, will ignore and discard any frames received from the remote station except an SABM/SABME or DISC command, or a UA or DM response. The receipt of an SABM/SABME or DISC command from the remote station will result in a collision situation that is resolved per § 2.4.4.5 above. Frames, other than a UA or DM response sent in response to a received SABM/SABME or DISC command, will be sent only after the data link is reset and if no outstanding SABM/SABME command exists.

After the station sends the SABM/SABME command, if a UA or DM response is not received correctly, Timer T1 will run out in the sending station. The station will then resend the SABM/SABME command and will restart Timer T1. After N2 attempts to reset the data link, the station will initiate appropriate higher layer recovery action and will enter the disconnected phase. The value of N2 is defined in § 2.4.8.4 below.

2.4.7.3 Request for Link Reset

A station (DCE or DTE) may ask the remote station to reset the data link by transmitting an FRMR response (see § 2.4.6.1 above). After transmitting an FRMR response, the station will enter the frame rejection condition.

The frame rejection condition is cleared when the station receives an SABM/SABME command, a DISC command, a FRMR response, or a DM response; or transmits an SABM/SABME command, a DISC command, or a DM response. Other commands received while in the frame rejection condition will cause the station to retransmit the FRMR response with the same information field as originally transmitted.

The station will start Timer T1 on transmission of the FRMR response. If Timer T1 runs out before the frame rejection condition is cleared, the station shall retransmit the FRMR response, and restart T1. If timer T1 is not started, or after N2 attempts (timeouts) to get the remote station to reset the data link, the station will reset the data link itself as described in § 2.4.7.2 above. The value of N2 is defined in § 2.4.8.4 below.

In the frame rejection condition, I frames and supervisory frames will not be transmitted by the station. Also, received I frames and supervisory frames will be discarded by the station except for the observance of a 'P = 1'. When an additional FRMR response must be transmitted by the station as a result of the receipt of a 'P = 1' while Timer T1 is running, Timer T1 will continue to run. Upon receipt of an FRMR response (even during a frame rejection condition), the station will initiate a resetting procedure by transmitting an SABM/SABME command as described in § 2.4.7.2 above, or will transmit a DM response to ask the remote station to initiate the data link set-up procedure as described in § 2.4.4.1 and enter the disconnected phase.

2.4.8 List of LAPB System Parameters

The DCE and DTE system parameters are as follows:

2.4.8.1 Time-Outs and Time-Limits

IBM SNA X.25 DTE timers are referenced using the terms:

start timer - meaning causing the timer to be switched on and begin counting down to zero from the time parameter value; and

reset timer - meaning causing the timer to be stopped immediately and switched off.

- DTE Timer, Tp (DCE Timer, T1)

  DTE Reply Timer, Tp, is used to prevent dead-lock conditions and to detect transmission errors due to faulty data link channel operation. The value of the DTE Reply Timer Tp system parameter may be different than the value of the DCE/remote DTE Timer T1 system parameter. These values shall be made known to both the DTE and the DCE/remote DTE and agreed to for a period of time by both the DTE and the DCE/remote DTE.

  The period of Timer Tp, at the end of which retransmission of a frame may be initiated (see §§ 2.4.4 and 2.4.5 above), shall take into account whether Tp is started at the beginning or at the end of frame transmission.

  The proper operation of the procedure requires that the transmitter's (DCE/remote DTE or DTE) Timer T1 or Tp be greater than the maximum time between transmission of a frame (SABM/SABME, DISC, I or supervisory command or DM or FRMR response) and the reception of the corresponding frame returned as an answer to that frame (UA, DM or acknowledging frame). Therefore, the receiver (DCE/remote DTE or DTE) should not delay the response or acknowledging frame returned to one of the above frames by more than a value T2, where T2 is a system parameter.

  The DCE will not delay response or acknowledging frames returned to one of the above DTE frames by more than T2.

- DTE Time-Out Function, (Ft)

  The duration of the time-out function (Ft) is:

  $$Ft = (Tp \bullet Np + Td) \bullet Nd$$

  where:

  The duration of DTE Reply Timer, Tp, is a function of the time allowed by DTEs between the transmission of command frames and receipt of the corresponding acknowledging frame.

Upon expiration of Reply Timer Tp, DTEs retransmit the command with 'P = 1' and restart Reply Timer Tp.

Np ≥'1' is the maximum number of transmissions and retransmissions of a frame following the expiration of Reply Time, Tp.

The duration of Delay Timer, Td, is typically many times greater than the duration of Reply Timer, Tp, and is the time to be delayed between consecutive repetitions of Tp•Np.

Nd ≥ '1' is the maximum number of repetitions of Tp•Np+Td to be performed before declaring the data link station to be inoperative.

Although the duration of Delay Timer, Td, may be defined as zero, experience has shown that when Td='0' and Nd='1' are used, links are often declared inoperative prematurely, causing unnecessary session outages and user dissatisfaction.

It is, therefore, highly recommended that Tp, Np, Td and Nd have default values that can be overridden by customers as experience indicates.

IBM SNA X.25 DTEs start Reply Timer, Tp, upon completion of transmission of I frames and supervisory command frames.

2.4.8.2 Response Timer, T2

The value of the DTE parameter T2 may be different than the value of the DCE/remote DTE parameter T2. These values shall be made known to both the DTE and the DCE/remote DTE, and agreed to for a period of time by both the DTE and the DCE/remote DTE.

The period of parameter T2 is the amount of time available at the DCE/remote DTE or DTE before transmission of the acknowledging frame must be initiated in order to ensure its receipt by the DTE or DCE/remote DTE, respectively, prior to Timer T1 or Tp running out at the DTE or DCE/remote DTE. T2 is less than T1.

To insure that responses to received frames are transmitted within the required time limit, IBM SNA X.25 DTEs may use Response Timer T2 when immediate transmission of a required response is not deemed desirable.

Note:

The period of parameter T2 shall take into account the following timing factors:

- the transmission time of the acknowledging frame,
- the propagation time over the access data link,
- the stated processing time at the DCE and the DTE, and
- the time to complete the transmission of the frame(s) in the DCE or DTE transmit queue that are neither displaceable or modifiable in an orderly manner.

Given a value for Timer T1 for the DTE or DCE, the value of parameter T2 at the DCE or DTE, respectively, must be no larger than T1 minus 2 times the propagation time over the access data link, minus the frame processing time of the acknowledging frame by the DCE or DTE, respectively.

2.4.8.3 DCE Timer T3

The DCE shall support a Timer T3 system parameter, the value of which shall be made known to the DTE. Timer T3 is optional to the DTE.

The period of Timer T3, at the end of which an indication of an observed excessively long idle channel state condition is passed to the Packet Layer, shall be sufficiently greater than the period of the DCE Timer T1 (i.e., T3 greater than T1) so that the expiration of T3 provides the desired level of assurance that the data link channel is in a non-active, non-operational state, and is in need of data link set-up before normal data link operation can resume.

2.4.8.4 Maximum Number of Attempts to Complete a Transmission, N2

The value of the DTE N2 system parameter may be different than the value of the DCE/remote DTE N2 system parameter. These values shall be made known to both the DTE and the DCE/remote DTE, and agreed to for a period of time by both.

The value of N2 shall indicate the maximum number of attempts made by the DCE/remote DTE or DTE to complete the successful transmission of a frame to the DTE or DCE/remote DTE, respectively. It is used to initialize or establish limits for the transmission of both I-frames and supervisory or unnumbered command frames with 'P = 1'.

2.4.8.5 Maximum Number of Bits in an I frame, N1

The value of the DTE N1 system parameter may be different than the value of the DCE/remote DTE N1 system parameter. These values shall be made known to both the DTE and the DCE/remote DTE, and agreed to for a period of time by both.

The value of N1 shall indicate the maximum number of bits in an I frame (excluding flags and '0' bits inserted for transparency) that the station DTE is willing to accept from the remote station.

In order to allow for universal operation, a DTE will support a value of DTE N1 which is not less than 1080 bits, (135 octets). DTEs should be aware that the network may transmit longer packets (see § 5.2), that may result in a data link layer problem.

All networks shall offer to a DTE which requires it, a value of DCE N1 which is greater than or equal to 2072 bits (259 octets) plus the length of the address, control and FCS fields at the DTE/DCE interface, and greater than or equal to the maximum length of the DATA packets which may cross the DTE/DCE interface plus the length of the address, control and FCS field at the DTE/DCE interface.

The following provides a description of how the values given for the parameter N1 are derived.

- DTE N1 - For universal operation, a DTE must be capable of accepting at least the largest packet that can be transmitted across a DTE/DCE interface when no options apply. This implies that the DTE may choose not to support, for example, any optional facilities for universal operations, but must support, for example, a DATA packet using the standard default packet size. Therefore, the determining factor for the maximum value of N1 that a DTE must support is the standard default packet size of a DATA packet rather than the size of a call setup packet. Thus, for universal operation a DTE should support a value of DTE N1 which is not less than 135 octets, derived as shown in the following table.

TABLE 8.1 Derivation of minimum value of N1 for DTE

name of the field	length of the field (octets)
Packet Header (Layer 3)	3
User Data (Layer 3)	128
Address (Layer 2)	1
Control (Layer 2)	1
FCS (Layer 2)	2
TOTAL	135

Note - A DTE will need to support larger values of N1 when optional facilities will apply.

- DCE N1 - When the maximum length of the data field of a DATA packet supported is less than or equal to the standard default value of 128 octets, the determining factor (for the value of DCE N1) is the CLEAR_REQUEST packet rather than the DATA packet. Therefore, the network shall offer to a DTE, a value of DCE N1 which is not less than 263 or 264 octets, derived as shown in the following table.

TABLE 8.2 Derivation of minimum value of N1 for DCE	
name of the field	length of the field (octets)
Header (Layer 3)	3
Clearing Cause (Layer 3)	1
Diagnostic Code (Layer 3)	1
DTE Address Length (Layer 3)	1
DTE Address(es) (Layer 3)	15
Facility Length (Layer 3)	1
Facilities (Layer 3)	109
Clear User Data (Layer 3)	128
Layer 3 Total	259
Address (Layer 2)	1
Control (Layer 2)	1 or 2*
Multilink Procedure	2**
TOTAL	263 or 264* or 265** or 266* **

* If Layer 2 Modulo 128 operation is supported.

** Multilink Procedures (MLP) are supported.

When the maximum length of the user data field of a DATA packet supported is greater than the standard default value of 128 octets, the determining factor (for the value of DCE N1) is the DATA packet rather than the CLEAR_REQUEST packet. Therefore, the network shall offer to a DTE, a value of DCE N1 which is greater than or equal to:
the maximum length of the DATA packet +
the length of the address field (Layer 2) +
the length of the control field (Layer 2) +
the length of the FCS field (Layer 2).

- GENERAL DCE N1 CALCULATIONS

The following table indicates the value of DCE N1 for each possible case. The table shows for each case whether

- Layer 2 Modulo 128 is used,
- Multilink Procedures are used,
- Layer 3 Modulo 128 is used, and/or

– the maximum length of the data field (p) in a DATA packet is greater than or equal to 256 octets.

Table 8.3 Various cases and corresponding minimum N1 values for a DCE				
Layer 2 Mod 128	MLP	Layer 3 Mod 128	p►=256	DCE N1 (octets)
				259 + 4*
	X			259 + 4* +2*****
			X	p + 3** + 4*
	X		X	p + 3** + 4* + 2*****
		X		259 + 4*
	X	X		259 + 4* + 2*****
		X	X	p + 3** + 1*** + 4*
	X	X	X	p + 3** + 1*** + 4* + 2*****
X				259 + 4* +1****
X	X			259 + 4* +1**** + 2*****
X			X	p + 3** + 1**** + 4*
X	X		X	p + 3** + 1**** + 4* +2*****
X		X		259 + 4* + 1****
X	X	X		259 + 4* + 1**** + 2*****
X		X	X	p + 3** + 1*** + 4* + 1****
X	X	X	X	p + 3** + 1*** + 4* + 1**** + 2*****

* The number of octets for Modulo 8 Layer 2 frame fields.
** The number of octets for Layer 3 packet header fields.
*** Additional octet for Layer 3 Modulo 128 operations.
**** Additional octet for Layer 2 Modulo 128 operations.
***** Additional octets for MLP support.

2.4.8.6 Maximum Number of Outstanding I frames, K

In the case of DTE/DCE operation, the value of the DTE K system parameter shall be the same as the value of the DCE K system parameter. This value shall be agreed to for a period of time by both the DTE and the DCE. In the case of DTE/DTE operation, the value of the DTE K system parameter may be different from the value of the remote DTE K system parameter. These values will be agreed to for a period of time by both the DTE and the remote DTE.

The value of K shall indicate the maximum number of sequentially numbered I frames that the DTE or DCE may have outstanding (i.e., unacknowledged) at any given time. The value of K shall never exceed seven (7) for modulo 8 (basic) operation, or one hundred twenty seven for modulo 128 (extended) operation. All networks (DCEs) and all DTEs shall support a value of seven. Other values may also be supported.

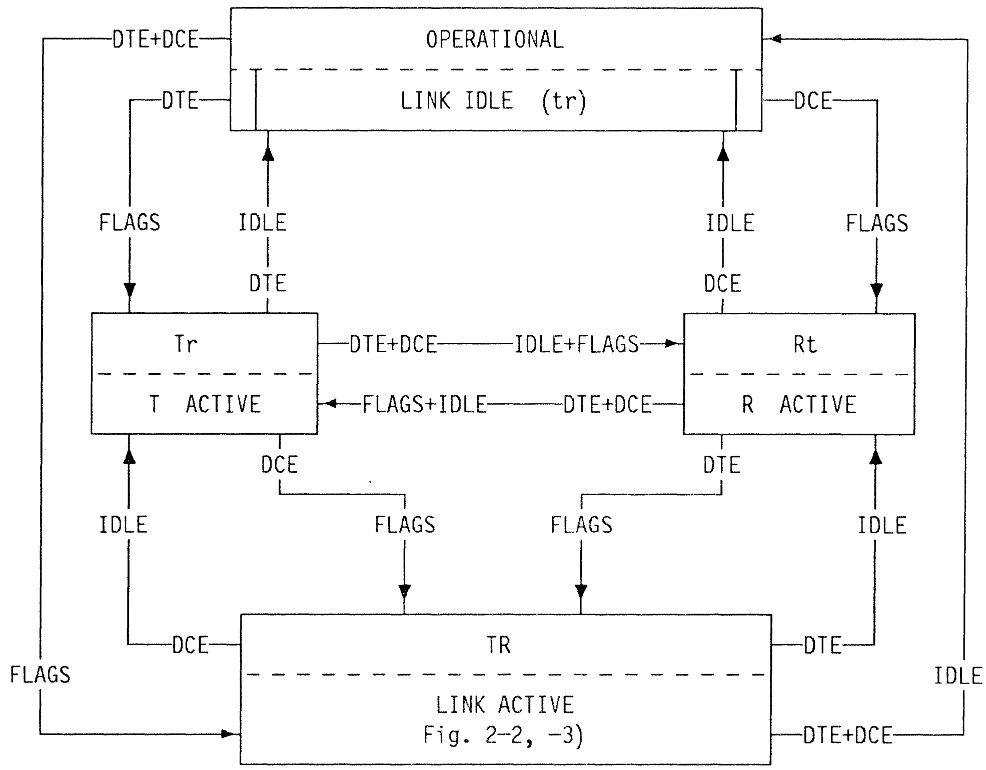
2.4.8.7 DTE Idle Timer, Ti (Called T4 in ISO 7776)

The purpose of the Idle Timer, which has a value of Ti, is to assist in preventing the persistence of an idle condition on a data link channel.

This is the period of time that a DTE may allow the idle channel state to exist before considering it to be in the disconnected phase (out-of-order state). Typically, the duration of Idle Timer, Ti, should be many times greater than the duration of Reply Timer, Tp.

2.4.8.8 Query Timer, Tn

This timer is used to detect excessive periods of data link inactivity. The period of Query Timer, Tn, is the time following receipt of a remote station busy indication after which a DTE initiates a 'P/F cycle' to assure the connection is operable. Query Timer, Tn, is typically equivalent to Reply Timer, Tp.



Legend:

R – Receive Data Link Channel Active
r – Receive Data Link Channel Idle
T – Transmit Data Link Channel Active
t – Transmit Data Link Channel Idle

Figure 2-1. Data Link Layer (Layer 2) LAPB_SLP. Activation

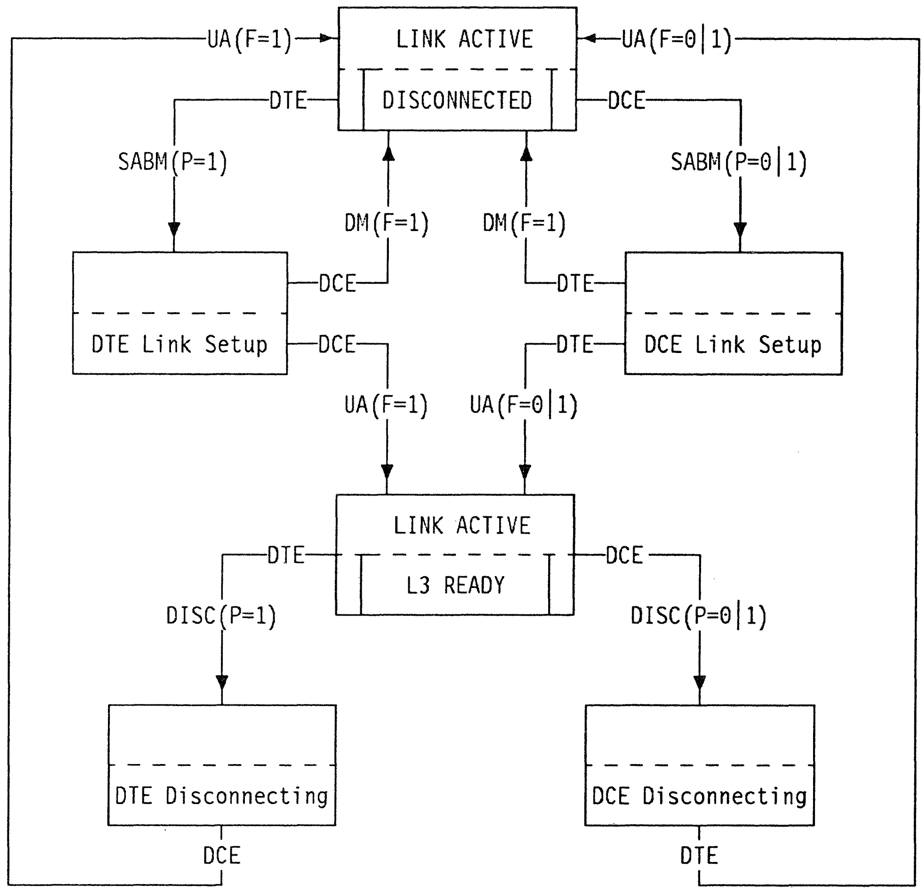


Figure 2-2. Data Link Layer (Layer 2) LAPB_SLP. Initialization/Disconnection

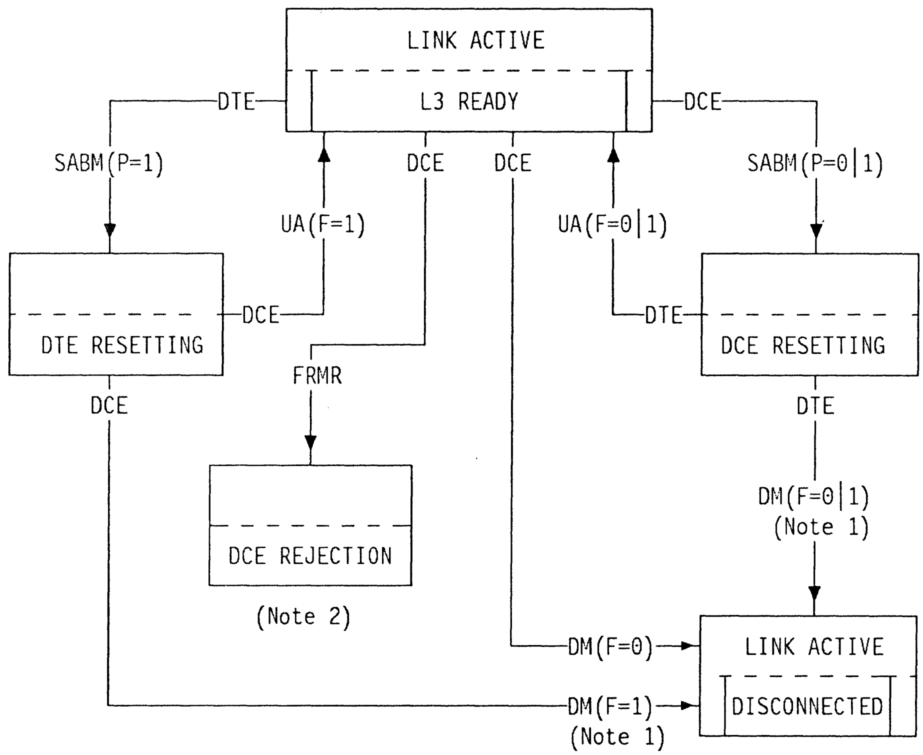


Figure 2-3. Data Link Layer (Layer 2) LAPB_SLP. Resetting

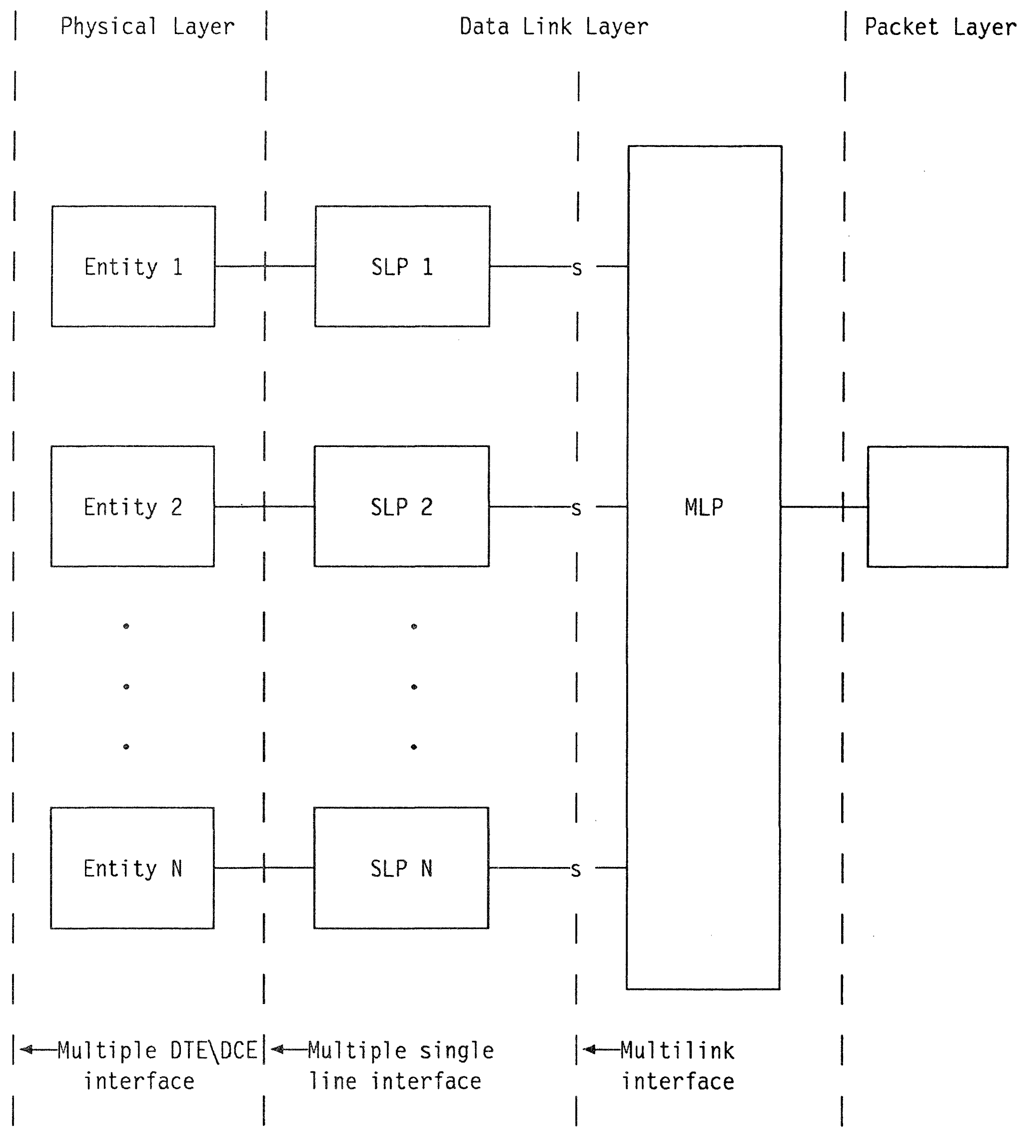
Notes with reference to Figure 2-3:

1. Transition is not allowed by some PSDN certification procedures. On those PSDNs, DTEs respond UA(F=0|1) to received SABM commands and then initiate the disconnection procedure to achieve this state.
2. In the DCE Rejection state, DTEs are responsible for restoring the data link to normal operation by initiating either the LAPB initialization procedure or the LAPB disconnection procedure.

2.5 Multilink Procedure - (MLP) (Subscription-time Selectable Option)

The Multilink procedure (MLP) exists as an added upper sublayer of the Data Link Layer, operating between the Packet Layer and more than one single data link protocol function (SLP) in the Data Link Layer (see figure below).

A multilink procedure (MLP) performs the functions of accepting packets from the Packet Layer, distributing those packets across the available SLPs for transmission, and resequencing the packets received from the SLPs for delivery to the Packet Layer.



s = Single link interface

Figure 2.3.5 Multilink Functional Organization

2.5.1 Field of Application

The optional multilink procedure (MLP) described in "Multilink Frame Structure" through "List of Multilink System Parameters" on page 2-58 is used for data interchange over one or more single link procedures (SLPs), each conforming to the description in §§ 2.2, 2.3 and 2.4, in parallel between a DCE or DTE and a DTE or DCE/remote DTE respectively. The multilink procedure provides the following general features:

- achieve economy and reliability of service by providing multiple SLPs between a station and a remote station;
- permit addition and deletion of SLPs without interrupting the service provided by the multiple SLPs;
- optimize bandwidth utilization of a group of SLPs through load sharing;
- achieve graceful degradation of service when an SLP(s) fails;
- provide each multiple SLP group with a single logical Data Link Layer appearance to the Packet Layer; and
- provide resequencing of the received packets prior to delivering them to the Packet Layer.

2.5.2 Multilink Frame Structure

All information transfers over a SLP are in multilink frames conforming to one of the formats shown in Table 9.

TABLE 9 – Multilink Frame Formats

			← Multilink Frame →		
F	A	C	M L C	FCS	F
			← 2 Octets →		

			← Multilink Frame	→		
F	A	C	M L C	Information	FCS	F
			← 2 Octets →			

KEY:
SLP = single line procedure
MLP = multiple line procedure

2.5.2.1 Multilink Control Field

The multilink control field (MLC) consists of two octets, and its contents are described in § 2.5.3.

2.5.2.2 Multilink Information Field

The information field of a multilink frame is used primarily for the transfer of packets and, when present, follows the MLC. See §§ 2.5.3.2.3 and 2.5.3.2.4 for the various codings and groupings of bits, other than the packets, in the multilink information field.

2.5.3 Multilink Control Field Format and Parameters

2.5.3.1 Multilink Control Field Format.

The relationship shown in Table 10 exists between the order of bits delivered to/received from an SLP and the coding of the fields in the multilink control field.

TABLE 10 - Multilink Control Field Format

Multilink Control Field

Order of Bits Delivered to/Received from an SLP

1 2 3 4	5	6	7	8	9 - - - - - - - - - - - - -16
MNHs	V	S	R	C	MNLs

2^8 2^{11} 2^0 2^7

Weight of bits in MN(S)

- Internal View -

Multilink Control Field

Order of Bits Delivered to/Received from an SLP

16 - - - - - - - - - - - - - 9	8	7	6	5	4 3 2 1
MNLs	C	R	S	V	MNHs

2^7 2^0 2^{11} 2^8

Weight of bits in MN(S)

MNHs - bits 9 - 12 of 12-bit multilink send sequence number MNs
MNLs - bits 1 - 8 of 12-bit multilink Send sequence number MNs
V - Void Sequencing Bit
S - Sequence Check Option Bit
R - MLP Reset Request Bit
C - MLP Reset Confirmation Bit

2.5.3.2 Multilink Control Field Parameters

The various parameters associated with the multilink control field format are described below. See Table 10 and Figure 2-4 on page 2-51.

- Void Sequencing Bit - (V)

  The void sequencing bit (V) indicates if a received multilink frame shall be subjected to sequencing constraints. V = '1' means sequencing is not required.

  Note:

  For purposes of this specification, 'V=0'.

- Sequence Check Option Bit - (S)

  The sequence check option bit (S) is only significant when 'V=1' (indicating that sequencing of received multilink frames is not required). 'S=1' means no MN(S) number has been assigned. 'S=0' means an MN(S) number has been assigned, so that although sequencing is not required, a duplicate multilink frame check may be made, as well as a missing multilink frame identified.

  Note:

  For purposes of this specification, 'S=0'.

- MLP Reset Request Bit - (R)

  The MLP reset request bit (R) is used to request a multilink reset (see § 2.5.4.2). 'R = 0' is used in normal communication, i.e., no request for a multilink reset. 'R = 1' is used by the DCE MLP or DTE MLP to request the reset of the DTE MLP or DCE MLP state variables, respectively. In this 'R = 1' case, the multilink information field does not contain Packet Layer information, but may contain an optional 8-bit Cause Field that incorporates the reason for the reset.

  Note:

  The encoding of the Cause Field is a subject for further study.

- MLP Reset Confirmation Bit - (C)

  The MLP reset confirmation bit (C) is used in reply to an 'R = 1' (see § 2.5.3.2.3) to confirm the resetting of the multilink state variables (see § 2.5.4.2). 'C = 0' is used in normal communications, i.e., no multilink reset request has been activated. 'C = 1' is used by the local station MLP or remote station MLP in reply to a remote station MLP or local station MLP multilink frame, respectively, with 'R = 1', and indicates that the local station MLP or remote station MLP state variable reset process has been completed by the local station or remote station, respectively. In this 'C = 1' case, the multilink frame is used without an information field.

- Multilink Send State Variable - MVs

  The multilink send state variable MVs denotes the sequence number of the next in-sequence multilink frame to be assigned to an SLP. This variable can take on the value '0' through '4095' (x'000 - FFF' (modulo 4096)). The value of MVs is incremented by '1' with each successive multilink frame assignment.

- Multilink Sequence Number - MNs

  Multilink frames contain the multilink sequence number MNs. Prior to the assignment of an in-sequence multilink frame to an available SLP, the value of MNs is set equal to the value of the multilink send state variable MVs. The multilink sequence number is used to resequence and to detect missing and duplicate multilink frames at the receiver before the contents of a multilink frame information field is delivered to the Packet Layer.

- Transmitted Multilink Frame Acknowledged State Variable - MVt

  MVt is the state variable at the transmitting DCE MLP or DTE MLP denoting the oldest multilink frame which is awaiting an indication that a DCE SLP or DTE SLP has received an acknowledgment from its remote DTE SLP or DCE SLP, respectively. This variable can take on the value '0' through '4095' (x'000 - FFF' (modulo 4096)). Some multilink frames with sequence numbers higher than MVt may already have been acknowledged.

- Multilink Receive State Variable - MVr

  The multilink receive state variable MVr denotes the sequence number at the receiving DCE MLP or DTE MLP of the next in-sequence multilink frame to be delivered to the Packet Layer upon receipt. This variable can take on the value '0' through '4095' (x'000 - FFF' (modulo 4096)). The value of MVr is updated as described in § 2.5.4.3.2 below. Multilink frames with higher sequence numbers in the DCE MLP or DTE MLP receive window may already have been received.

- Multilink Window Size - MW

  MW is the maximum number of sequentially numbered multilink frames that the DCE MLP or DTE MLP may transfer to its SLPs beyond the lowest numbered multilink frame which has not yet been acknowledged. MW is a system parameter which can never exceed 4095 - MX. The value of MW shall be agreed to for a period of time with the Administration and shall have the same value for both the DCE MLP and the DTE MLP for a given direction of information transfer.

  Note:

  > Factors which will affect the value of parameter MW include, but are not limited to, single link transmission and propagation delays, the number of links, the range of multilink frame lengths, and SLP parameters N2, T1 and k.
  >
  > The MLP transmit window contains the sequence numbers MVt to MVt+MW-1, inclusive.

  The MLP receive window contains the sequence numbers MVr to MVr+MW-1, inclusive. Any multilink frame received within this window shall be delivered to the Packet Layer when its MNs becomes the same as MVr.

- Receive MLP Window Guard Region - MX

  MX is a system parameter which defines a guard region of multilink sequence numbers of fixed size beginning at MVr+MW. The range of MX shall be large enough for the receiving MLP to recognize the highest MNs outside of its receive window that it may legitimately receive after a multilink frame loss has occurred.

  A multilink frame with sequence number MNs=Y received in this guard region indicates that those missing multilink frame(s) in the range MVr to Y-MW has(have) been lost. MVr is then updated to Y-MW+1.

Note:

A number of methods may be selected in calculating a value for the guard region MX:

1. In a system where the transmitting MLP assigns hi in-sequence contiguous multilink frames at a time to the ith SLP, MX should be greater than or equal to the sum of the hi+1-hmin, where hmin equals the smallest hi encountered. Where there are L SLPs in the multilink group, MX should be greater than or equal to:

```
 L
Sum hi+1-hmin; or
i=1
```

2. In a system where the transmitting MLP assigns on a rotation basis h in-sequence contiguous multilink frames at a time to each SLP, MX at the receiving MLP should be greater than or equal to h(L-1)+1, where L is the number of SLPs in the multilink group; or
3. MX should be no larger than MW.

Additional methods of selecting MX values are being studied by the CCITT.

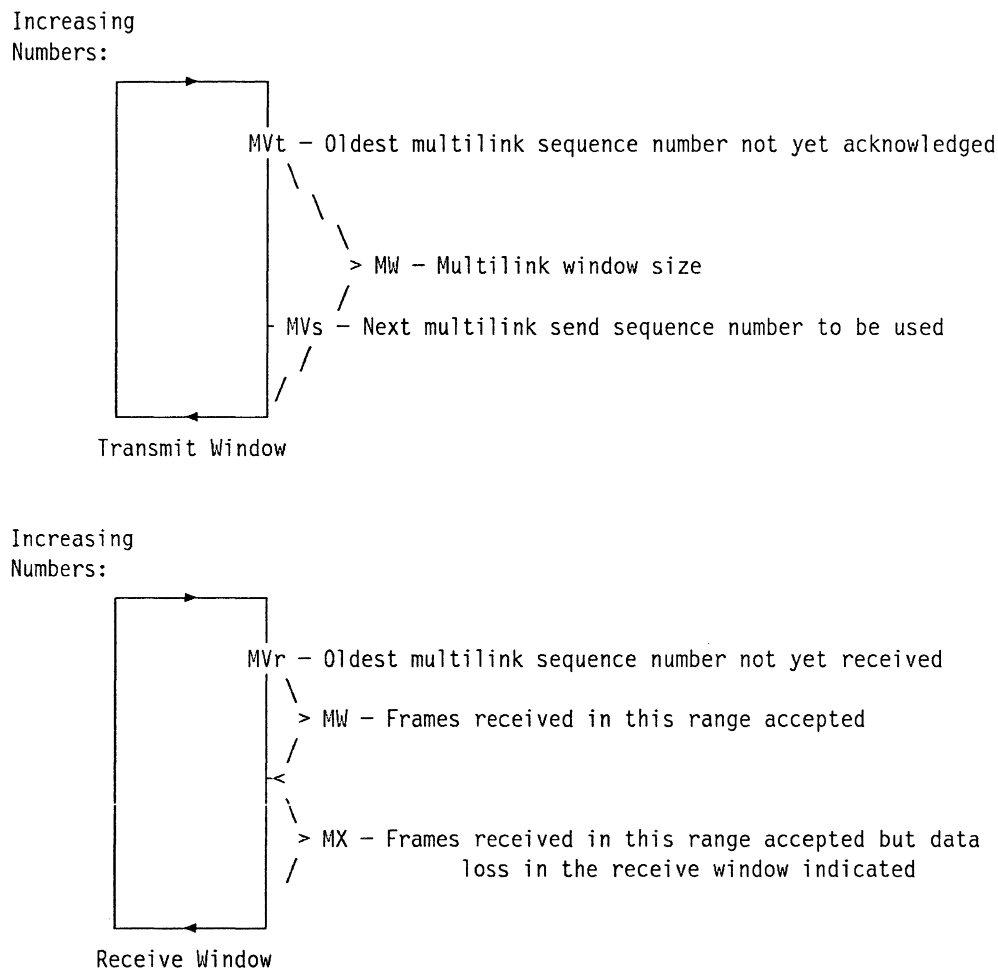


Figure 2-4. Parameter Descriptions

2.5.4 Description of the Multilink Procedure (MLP)

The procedure below is presented from the perspective of the transmitter and receiver of multilink frames.

The arithmetic is performed modulo 4096.

2.5.4.1 Initialization

The DCE or DTE will perform an MLP initialization by first resetting MVs, MVt and MVr to zero and then initializing each of its SLPs. Upon successful initialization of at least one of the SLPs, the DCE shall, and the DTE should, perform the multilink resetting procedure as described in § 2.5.4.2. An SLP initialization is performed according to § 2.4.4.1 of this specification.

Note:

An SLP that cannot be initialized should be declared out of service and appropriate recovery action should be taken.

2.5.4.2 Multilink Resetting Procedures

The multilink resetting procedure provides the mechanism for synchronizing the sending and receiving MLPs in both the DCE and the DTE, when deemed necessary by either the DCE or the DTE. Exact cases where the MLP resetting procedures are invoked are for further study. Following a successful multilink resetting procedure, the multilink sequence numbering in each direction begins with the value '0'.

Table Figure 2-3 on page 2-43 provides examples of the multilink resetting procedures when initiated by either the DCE or the DTE, or by both the DCE and the DTE simultaneously.

A multilink frame with 'R = 1' is used to request multilink reset, and (transmission and reception of) a multilink frame with 'C = 1' confirms that the multilink reset process has been completed. An MLP resets (its) MVs and MVt to zero on transfer of (when it sends) a multilink frame with 'R = 1'; and resets (its) MVr to zero on receipt of a multilink frame with 'R = 1'.

When the DCE MLP or DTE MLP initiates the resetting procedure,

- it removes all of the unacknowledged multilink frames that are held in that MLP and its associated SLPs, and retains control of those frames.
- Hereafter, the initiating MLP does not transfer a multilink frame with 'R = C = 0' until the reset process is completed. (One method to remove multilink frames in the SLP is to disconnect the data link of that SLP.)
- The initiating MLP then resets its multilink send state variable MVs and
- its transmitted multilink frame acknowledged variable MVt to zero.
- The initiating MLP then transfers a multilink frame with 'R = 1' as a reset request on one of its SLPs and starts Timer MT3. The value of the MNs field in the 'R = 1' frame may be any value, since when 'R = 1' the MNs field is ignored by the receiving MLP.
- The initiating MLP continues to receive and process multilink frames from the remote MLP, in accordance with the procedures as described in § 2.5.4.4 below
- until it receives a multilink frame with 'R = 1' from the remote MLP.

An MLP which has received a multilink frame with 'R = 1' (reset request) in the normal communication status from an initiating MLP starts the (resetting) operation as described (from (1) unless it has already initiated its own multilink resetting procedure) above; the MLP should receive no multilink frame with 'R = C = 0' from the other MLP until the reset process is completed. Any such multilink frame received is discarded. When an MLP has already initiated its own multilink resetting procedure and has transferred the multilink frame with 'R = 1' to one of its SLPs for transmission, that MLP does not repeat the above operation upon receipt of a multilink frame with 'R = 1' from the other MLP.

IBM SNA X.25 DTEs that use the multilink procedure discard any multilink frames that are received following the receipt of a reset request (R = '1') until the resetting procedure has been completed.

Receipt of a frame with 'R = 1' (reset request) causes the receiving MLP to

- deliver to the Packet Layer those packets already received and
- to identify those multilink frames assigned to SLPs but unacknowledged.
- The Packet Layer may be informed of the packet loss at the original value of MVr and
- at any subsequent value(s) of MVr for which there has been no multilink frame received up to and including the highest numbered multilink frame received. The receiving MLP then
- resets its multilink receive state variable MVr to zero.

After an MLP assigns a multilink frame with 'R = 1' to one of its SLPs, it shall receive indication of successful or unsuccessful transmission from that SLP as one of the conditions before transferring a multilink frame with 'C = 1'; when the initiating MLP then receives a multilink frame with 'R = 1', and has completed the multilink state variable resetting operation described above, the initiating MLP transfers a multilink frame with 'C = 1' (reset confirmation) to the other MLP. When an MLP has:

- received a multilink frame with 'R = 1',
- transferred a multilink frame with 'R = 1' on one of its SLPs, and
- completed the multilink state variable resetting operation above,

that MLP then transfers a multilink frame with 'C = 1' (reset confirmation) to the other MLP as soon as possible, given that indication of the successful or unsuccessful transmission of the 'R = 1' multilink frame has been received from that MLP's SLP. The 'C = 1' multilink frame is a reply to the multilink frame with 'R = 1'. The value of the MNs field in the above 'C = 1' frame may be any value, since when 'C = 1' the MNs field is ignored by the receiving MLP. The multilink sequence number MNs received in each direction following multilink reset will begin with the value zero.

When an MLP uses only one SLP to transmit the multilink frame with 'R = 1' and the multilink frame with 'C = 1', the MLP can transfer the multilink frame with 'C = 1' immediately after the multilink frame with 'R = 1' without waiting for SLP indication of transmission completion. An MLP shall not retransmit a multilink frame with 'R = 1' or a multilink frame with 'C = 1' unless Timer MT3 (see § 2.5.5.3 below) runs out. An MLP may use two different SLPs as long as one is used for transmitting the multilink frame with 'R = 1' and the other is used for transmitting the multilink frame with 'C = 1' following receipt of the SLP indication of successful or unsuccessful transmission of the 'R = 1' multilink frame. A multilink frame with 'R = C = 1' is never used.

When an MLP receives the multilink frame with 'C = 1', the MLP stops its Timer MT3. The transmission of the multilink frame with 'C = 1' to a remote SLP and the reception of a multilink frame with 'C = 1' from the remote MLP completes the multilink resetting procedure for an MLP. The first multilink frame transferred with 'R = C = 0' shall have a multilink sequence number MNs value of zero. After an MLP transfers a multilink frame with 'C = 1' to an SLP, the MLP may receive one or more multilink frames with 'R = C = 0'. After an MLP receives a multilink frame with 'C = 1', the MLP may transfer one or more multilink frames R = C = '0' to its SLP.

When an MLP additionally receives one or more multilink frames with 'R = 1' between receiving a multilink frame with 'R = 1' and transferring a multilink frame with 'C = 1', the MLP shall discard the extra multilink frames with 'R = 1'. When an MLP receives a multilink frame with 'C = 1', which is not a reply to a multilink frame with 'R = 1', the MLP discards the multilink frame with 'C = 1'.

After an MLP transfers a multilink frame with 'C = 1' on one of its SLPs, the MLP may receive a multilink frame with 'R = 1' from the other MLP. The MLP shall regard the multilink frame with 'R = 1' as a new reset request and shall start the multilink resetting procedure from the beginning. When an MLP which has not received a multilink frame with 'R = 1', transfers a multilink frame with 'R = 1', and therefore receives a multilink frame with 'C = 1', the MLP shall restart the resetting procedure from the beginning.

When Timer MT3 runs out, the MLP restarts the multilink resetting procedure from the beginning. The value of Timer MT3 shall be large enough to include the transmission, retransmission and propagation delays in the SLPs, and the operation time of the MLP that receives a multilink frame with 'R = 1' and responds with a multilink frame with 'C = 1'.

2.5.4.3 Transmitting Multilink Frames

2.5.4.3.1.General

The transmitting DCE or DTE MLP shall be responsible for controlling the flow of packets from the Packet Layer into multilink frames and then to the SLPs for transmission to the receiving DTE or DCE MLP, respectively.: The functions of the transmitting DCE or DTE MLP shall be to:

- accept packets from the Packet Layer;
- allocate multilink control fields, containing the appropriate sequence number MNs, to the packets,
- assure that MNs is not assigned outside the MLP transmit window (MW);
- pass the resultant multilink frames to the SLPs for transmission;
- accept indications of successful transmission acknowledgements from the SLPs;
- monitor and recover from transmission failures or difficulties that occur at the SLP sublayer; and
- accept flow control indications from the SLPs and take appropriate actions.

2.5.4.3.2 Transmission of Multilink Frames When the transmitting station MLP accepts a packet from the Packet Layer, it shall place the packet in a multilink frame, set the MNs equal to MVs, assure that MNs is not assigned outside the transmit window (MW), set V, S, R and C to '0', and then increment MVs by '1'.: In the following, incrementing send and receive state variables is in reference to a continuously repeated sequence series, i.e., 4095 is 1 higher than 4094, and 0 is 1 higher than 4095 for modulo 4096 series.

If the MNs is less than MVt + MW, and the remote station has not indicated a busy condition on all available station SLPs, the transmitting station MLP may then assign the new multilink frame to an available station SLP. The transmitting station MLP shall always assign the lowest MNs unassigned multilink frame first. Also, the transmitting station MLP may assign a multilink frame to more than one station SLP.

When the DCE or DTE SLP successfully completes the transmission of (a) multilink frame(s) by receiving an acknowledgment from the remote station SLP, it shall indicate this to the transmitting station MLP.

The transmitting station MLP may then discard the acknowledged multilink frame(s). As the transmitting station receives new indications of acknowledgments from the station SLPs, MVt shall be advanced to denote the lowest multilink frame not yet acknowledged.

Whenever a station SLP indicates that it has attempted to transmit a multilink frame N2 times, the station MLP will then assign the multilink frame to the same or one or more other station SLPs unless the MNs has been acknowledged on some previous station SLP. The station MLP shall always assign the lowest MNs multilink frame first.

Note:

> If a station MLP implementation is such that a multilink frame is assigned to more than one station SLP (e.g., to increase the probability of successful delivery) there is a possibility that one of these multilink frames (i.e., a duplicate) may be delivered to the remote station MLP after an earlier one has been acknowledged (the earlier multilink frame would have resulted in the receiving station MLP having incremented its MVr and the transmitting station MLP having incremented its MVt). To ensure that an old duplicate multilink frame is not mistaken for a new frame by the receiving station MLP, it is required that the transmitting station MLP shall never assign a station SLP a new multilink frame with MNs equal to MNs′-MW-MX, where MNs′ is associated with a duplicate multilink frame that was earlier assigned to other station SLPs, until all station SLPs have either successfully transmitted the multilink frame MNs′ or have attempted the transmission the maximum number of times.
>
> Alternatively, the incrementing of MVt may be withheld until all station SLPs that were assigned the multilink frame MNs′ have either successfully transferred the multilink frame MNs′ or have attempted the transmission the maximum number of times. These and other alternatives are for further study.

Flow control is achieved by the window size parameter MW, and through busy conditions being indicated by the remote station SLPs.

The station MLP will not assign a multilink frame with an MNs greater than MVt+MW-1. At the point where the next station multilink frame to be assigned has an MNs=MVt+MW, the station MLP shall hold this and subsequent multilink frames until an indication of an acknowledgement that advances MVt is received from the station SLPs.

The remote station MLP may exercise flow control of the station MLP by indicating a busy condition over one or more remote station SLPs. The number of SLPs made busy will determine the degree of station MLP flow control realized. When the station MLP receives an indication of a remote station SLP busy condition from one or more of its station SLPs, the station MLP may reassign any unacknowledged multilink frames that were assigned to those station SLPs. The station MLP will assign the multilink frames containing the lowest MNs to an available station SLP as specified above.

In the event of a circuit failure, a station SLP reset, or a station SLP or remote station SLP disconnection, all station MLP multilink frames that were unacknowledged on the affected station SLPs shall be reassigned to an operational station SLP(s) which is(are) not in the busy condition.

2.5.4.4 Receiving Multilink Frames

Any multilink frame less than two octets in length shall be discarded by the receiving station MLP.

Note:

> The procedures to be followed by the receiving station MLP when V and/or S is equal to '1' are for further study. The procedures to be followed by the receiving station MLP when 'R' or 'C' is equal to '1' are described in § 2.5.4.2 above.

When the station MLP receives multilink frames from one of the station SLPs, the station MLP will compare the multilink sequence number MNs of the received multilink frame to its multilink receive state variable MVr, and act on the multilink frame as follows:

- If the received MNs is equal to the current value of MVr, i.e., is the next expected in-sequence multilink frame, the station MLP delivers the packet to the Packet Layer.
- If the MNs is greater than the current value of MVr but less than MVr+MW+MX, the station MLP keeps the received multilink frame until condition a) is met, or discards it if it is a duplicate.
- If the MNs is other than a) and b) above, the multilink frame is discarded.

Note:

> In case c) above, the recovery from desynchronization greater than MX between the local and the remote MLP, i.e., the value of MNs assigned to new multilink frames at the remote MLP is higher than MVr + MW + MX at the local MLP, is for further study.

On receipt of each multilink frame, MVr is incremented by the station MLP in the following way:

i) If MNs is equal to the current value of MVr, the MVr is incremented by the number of consecutive in-sequence multilink frames that have been received. If additional multilink frames are awaiting delivery pending receipt of a multilink frame with MNs equal to the updated MVr, then Timer MT1 (see § 2.5.5.1 below) is restarted; otherwise, Timer MT1 is stopped.

ii) If MNs is greater than the current value of MVr, but less than MVr+MW, MVr remains unchanged. Timer MT1 is started, if not already running.

iii) If MNs is $\geq$ MVr + MW but $<$ MVr + MW + MX, MVr is incremented to MNs-MW+1 and then the Packet Layer may be informed of the packet loss at the original value of MVr. As MVr is being incremented, if any multilink frame with MNs=MVr has not yet been received, the Packet Layer may be informed of that packet loss also; if the multilink frame with MNs=MVr has been received, it is delivered to the Packet Layer. After MVr reaches MNs-MW+1, it will be incremented further (as in i) above) until the first unacknowledged MNs is encountered.

iv) If the MNs is other than that in i), ii) and iii) above, MVr remains unchanged.

If Timer MT1 runs out, MVr is incremented to the MNs of the next multilink frame awaiting delivery to the Packet Layer and then the Packet Layer may be informed of the packet loss at the original MVr. The procedure follows a) and i) above as long as there are consecutive in-sequence multilink frames which have been received.

When flow control of the remote station MLP is desired, one or more station SLP(s) may be made to indicate a busy condition. The number of station SLPs made busy determines the degree of flow control realized.

If the station MLP can exhaust its receive buffer capacity before resequencing can be completed, Timer MT2 (see § 2.5.5.2 below) may be implemented. Whenever a busy condition is indicated by the station MLP on all station SLPs, and multilink frames at the station MLP are awaiting resequencing, Timer MT2 shall be started. When the busy condition is cleared on one or more station SLPs by the station MLP, Timer MT2 shall be stopped.

If Timer MT2 runs out, the multilink frame with MNs=MVr is blocked and shall be considered lost. MVr shall be incremented to the next in-sequence number not yet received, and the packets contained in multilink frames with intervening multilink sequence numbers are delivered to the Packet Layer. Timer MT2 shall be restarted if the busy condition remains in effect on all station SLPs and more multilink frames are awaiting resequencing.

2.5.4.5 Taking an SLP Out of Service

A station SLP may be taken out of service for maintenance, traffic, or performance considerations.

A station SLP is taken out of service by disconnecting at the Physical Layer or the Data Link Layer. Any outstanding station MLP multilink frames will be reassigned to one or more other station SLPs, unless the MNs has been previously acknowledged on some other station SLP. The usual procedure for taking a SLP out of service at the Data Link Layer would be to flow control the remote station SLP with an RNR frame, and then logically disconnect the station SLP (see § 2.4.4.3 above).

If the station SLP Timer T1 has run out N2 times and the station SLP link resetting procedure is unsuccessful, then the station SLP will enter the disconnected phase, taking the station SLP out of service (see §§ 2.4.5.8 and 2.4.7.2 above).

Note:

In case where all SLPs are out of service, the recovery mechanism is based on initiating the multilink resetting procedures. Other recovery procedures are for further study.

2.5.5 List of Multilink System Parameters

2.5.5.1 Lost-Frame Timer MT1 (Multilink)

Timer MT1 is used at a receiving station MLP to provide a means to identify during low traffic periods that the multilink frame with MNs equal to MVr is lost.

2.5.5.2 Group Busy Timer MT2 (Multilink)

Timer MT2 is provided at a receiving station MLP to identify a "blocked" multilink frame condition (e.g., a buffer exhaust situation) that occurs before required resequencing can be accomplished. Timer MT2 is started when all station SLPs are busy and there are multilink frames awaiting resequencing. If Timer MT2 runs out before the "blocked" multilink frame MVr is received, the "blocked" multilink frame(s) is(are) declared lost. MVr is incremented to the value of the next in-sequence multilink frame to be received, and any packets in intervening multilink frames are delivered to the Packet Layer.

Note:

Timer MT2 may be set to infinity; e.g., when the receiving station always has sufficient storage capacity.

2.5.5.3 MLP Reset Confirmation Timer MT3 (Multilink)

Timer MT3 is used by the station MLP to provide a means of identifying that the remote station MLP multilink frame with the 'C = 1' that is expected following the transmission of the station MLP multilink frame with 'R = 1', has not been received.

2.6 LAP Elements of Procedure

Applicable only to certain early IBM SNA X.25 DTE implementations and beyond the scope of this specification.

2.7 Description of the LAP Procedure

Available only in certain early IBM SNA X.25 DTE implementations and beyond the scope of this specification.

Chapter 3. Description of the Packet Layer DTE/DCE Interface

This and subsequent sections relate to the transfer of packets at the DTE/DCE interface for both SNA-to-SNA connections and for SNA-to-non SNA connections. The procedures apply to packets that are successfully transferred across the DTE/DCE interface. It also covers the additional Packet Layer procedures necessary for two DTEs conforming to CCITT Recommendation X.25 to communicate directly (i.e., without an intervening packet-switched network) over a dedicated path or a circuit-switched connection.

Each packet transferred across the DTE/DCE or DTE/DTE interface is contained within the data link layer information field which delimits its length, and only one packet is contained within the information field.

Note:

Some networks require the data fields of packets to contain an integral number of octets. Transmission by the DTE of data fields not containing an integral number of octets to networks may cause a loss of data integrity. DTEs wishing universal operation on all networks should transmit all packets with data fields containing only an integral number of octets. Full data integrity can only be assured by exchange of octet-oriented data fields in both directions of transmission.

IBM SNA X.25 DTEs transmit and receive packets with User_Data fields that contain an integral number of octets only.

This section covers a description of the packet layer interface for virtual call and permanent virtual circuit services.

Note:

Although the term 'Switched Virtual Circuit' (SVC) is not defined by CCITT Recommendation X.25 it is widely used as a synonym for virtual call (VC) service.

For SNA-to-SNA connections, virtual circuits (virtual calls or permanent virtual circuits) are treated, by SNA, as real links that can accommodate multiple SNA sessions. Permanent virtual circuits are managed like non-switched links while virtual calls are managed either like switched links or like non-switched links depending upon the implementation at the IBM SNA X.25 DTE. Except for the IBM 5973 Network Interface Adapter (NIA), IBM SNA X.25 DTEs must support 'Qualified' data packets for Logical Link Control (QLLC) to perform adjacent SNA node physical services (see § 8.0). Adjacent SNA node physical services, segmentation and sequence numbering may be performed with an optional Physical Services Header (PSH) as described in Appendix J, "Physical Services Headers" only for compatibility with the IBM 5973 NIA.

For SNA-to-non SNA connections, transformation between X.25 and SNA protocols may be performed at SNA boundary network nodes. In this environment several implementation approaches can be used as described in Appendix K, "SNA-to-non_SNA Architectural Considerations."

SNA-to-SNA connections and SNA-to-non SNA connections differ only at the packet layer. Thus, the previous points (§§ 1.0 and 2.0) apply equally to both types of connection. In the following points (§§ 3.0, 4.0, 5.0, 6.0 and 7.0), functions, facilities, formats and procedures that apply only to SNA-to-non SNA connections are enclosed in brackets (e.g., [text]).

Procedures for virtual circuit service (i.e., virtual call and permanent virtual circuit services) are specified in § 4.0. Packet formats are specified in § 5.0. Procedures and formats for optional user facilities are specified in §§ 6.0 and 7.0.

3.1 Logical Channels

To enable simultaneous virtual calls and/or permanent virtual circuits, logical channels are used. Each virtual call and permanent virtual circuit is assigned a logical channel group number (LCGN, less than or equal to 15) and a logical channel number (LCN, less than or equal to 255). For virtual calls, a logical channel group number and a logical channel numbe, are assigned during the call set-up phase. The range of logical channels used for virtual calls is agreed upon with the network Administration at the time of subscription to the service (see Appendix A, "Logical Channel Ranges"). For permanent virtual circuits, logical channel group numbers and logical channel numbers are assigned in agreement with the Administration at the time of subscription to the service (see Appendix A, "Logical Channel Ranges").

The logical channel group number and the logical channel number may be managed as a single twelve-bit entity (logical channel identifier - LCI).

3.2 Structure of Packets

Every packet transferred across the DTE/DCE interface consists of at least three octets. These three octets contain a general format identifier (GFI), logical channel identifier (LCI) and a packet type identifier (PTI). Other fields are appended to packets as required (see § 5).

Packet types and their use in association with various services are given in Table 14.

TABLE 14: Packet Types and Their Use in Various Services

PACKET TYPE		SERVICE		
From DCE to DTE	From DTE to DCE	VC	PVC	I/F
CALL SET-UP AND CLEARING (1)				
INCOMING_CALL - (INC)	CALL_REQUEST - (CRQ)	X		
CALL_CONNECTED - (CCN)	CALL_ACCEPTED - (CAC)	X		
CLEAR_INDICATION - (CLI)	CLEAR_REQUEST - (CLR)	X		
DCE_CLEAR_CONFIRMATION - (NCC)	DTE_CLEAR_CONFIRMATION - (TCC)	X		
DATA [AND INTERRUPT] (2)				
DCE_DATA - (NDT)	DTE_DATA - (TDT)	X	X	
[DCE_INTERRUPT] - (NIN)	[DTE_INTERRUPT] - (TIN)	[X]	[X]	
[DCE_INTERRUPT_ CONFIRMATION] - (NIC)	[DTE_INTERRUPT_ CONFIRMATION] - (TIC)	[X]	[X]	
FLOW CONTROL AND RESET (3,7)				
DCE_RR - (NRR)	DTE_RR - (TRR)	X	X	
DCE_RNR - (NNR)	DTE_RNR - (TNR)	X	X	
RESET_INDICATION - (RSI)		X	X	
	RESET_REQUEST - (RSR)		X	
DCE_RESET_CONFIRMATION - (NRC)	DTE_RESET_CONFIRMATION - (TRC)		X	
RESTART (4)				
RESTART_INDICATION - (IRI)	RESTART_REQUEST - (IRR)			X
DCE_RESTART_CONFIRMATION - (NSC)	DTE_RESTART_CONFIRMATION - (TRC)			X
DIAGNOSTIC (5)				
DIAGNOSTIC - (DGN) a)				X
REGISTRATION a) (6)				
REGISTRATION_ CONFIRMATION - (RCN)	REGISTRATION_ REQUEST - (RRQ)			X

a) - Not necessarily available on all networks.
VC = Affects given Virtual Calls
PVC = Affects given Permanent Virtual Circuits
I/F = Affects all VCs and PVCs at the DTE/DCE Interface

Notes:

1 - See §§ 4.1 and 6.6 for procedures, § 5.2 for formats.
2 - See § 4.3 for procedures and § 5.3 for formats.
3 - See §§ 4.4 and 6.4 for procedures, §§ 5.4 and 5.7.1 for formats.
4 - See § 3.3 for procedures, § 5.5 for formats.
5 - See § 3.4 for procedures, § 5.6 for formats.
6 - See § 6.1 for procedures, § 5.7.2 for formats.
7 - DTE REJ packets are not used.

3.3 Procedure for Restart

The restart procedure is used to initialize or reinitialize the packet layer DTE/DCE interface (or DTE/DTE interface in the case of DTE/DTE operation). The restart procedure simultaneously clears all virtual calls and resets all permanent virtual circuits at the interface (see § 4.5).

Figure B-1 on page B-2 gives the state diagram which defines the logical relationships of events related to the restart procedure.

Table C-2 "DCE State/Action Tables" on page C-2 specifies actions taken by the DCE upon receipt of packets from the DTE for the restart procedure.

Appendix I, "Description of DTE Packet Layer Actions" specifies actions taken by the DTE on receipt of packets from the DCE for the restart procedure.

3.3.1 Restart by the DTE

The DTE may at any time, after link initialization is complete, request a restart by transferring across the interface a RESTART_REQUEST packet and starting the Restart Request Response Timer (T20). The Diagnostic Code field in RESTART_REQUEST packets is coded x'00' to indicate initial restart (see Appendix H, "DTE-Generated Diagnostic Codes" for SNA-to-SNA connections). The interface for each logical channel is then in the DTE_Restart_Request state (r2). In this state, the DTE will ignore all packets except RESTART_CONFIRMATION, RESTART_INDICATION, REGISTRATION_REQUEST (DTE/DTE environment only), REGISTRATION_CONFIRMATION, and DIAGNOSTIC packets. Therefore, higher layer entities must be able to cope with the various possible situations that may occur.

The failure to receive a RESTART_CONFIRMATION packet or a RESTART_INDICATION packet before expiration of T20 after transmission of a RESTART_REQUEST packet is considered an error. The restart procedure is retried up to a maximum number of times R20. After this the Packet Layer notifies the appropriate entity that it has not received a confirmation of the restart procedure. Each logical channel then remains in the DTE_Restart_Request state (R2).

The DCE will confirm the restart by transferring a DCE_RESTART_CONFIRMATION packet placing the logical channels used for virtual calls in the Ready state (p1), and logical channels used for permanent virtual circuits in the Flow_Control_Ready state (d1).

Note:

States p1 and d1 are specified in § 4.

The DCE_RESTART_CONFIRMATION packet can only be interpreted universally as having local significance. The time spent in the DTE_Restart_Request state (r2) will not exceed time-limit T20 (see Appendix D, "DCE Time-outs and DTE Time-limits"). In this state, DTEs ignore all packets, except RESTART_INDICATION and DCE_RESTART_CONFIRMATION. If the DCE does not confirm this restart within 200 seconds, the RESTART_REQUEST packet can be retransmitted after the 200 second timer is reinitialized. If the total time spent in state (r2) exceeds 'n' times 200 seconds, where 'n $\geq$ 1', notification of failure of the DTE/DCE interface must be reported to a higher layer by IBM SNA

X.25 DTEs using the Diagnostic "Timer Expired - RESTART Packet" #52 (x'34'). The DTE/DCE interface must be placed in an inoperative state.

Note:

[The Restarting Cause field in RESTART_REQUEST packets on SNA-to-non_SNA connections is set to x'00' and the Diagnostic Code field is coded according to Table E-1 (see Appendix E, "Network Generated Diagnostic Codes")].

3.3.2 Restart by the DCE

The DCE will indicate a restart by transferring a RESTART_INDICATION packet across the DTE/DCE interface. The interface for each logical channel (both DTE and DCE) is then in the DCE_Restart_Indication state (r3). In this state of the DTE/DCE interface, the DCE will ignore all packets except for RESTART_REQUEST and DTE_RESTART_CONFIRMATION. In this state, the DTE considers subsequent receipt of any packet, other than another RESTART_INDICATION, REGISTRATION_REQUEST (DTE/DTE environment only), REGISTRATION_CONFIRMATION, and DIAGNOSTIC packets as an error. It discards any such packet and transmits a RESTART_REQUEST packet with a cause indicating "DTE-Originated" and the diagnostic "Packet Type Invalid For State r3."

Note:

In a DTE/DTE environment, the RESTART_INDICATION packet received by one DTE is the same as the RESTART_REQUEST packet transmitted by the other DTE.

IBM SNA X.25 DTEs report restarting cause and diagnostic codes contained in RESTART_INDICATION packets to a higher layer.

The DTE will confirm the restart by transmitting a DTE_RESTART_CONFIRMATION packet across the DTE/DCE interface, before timer T10 elapses, and placing all logical channels used for virtual calls in the READY state (p1) and all logical channels used for permanent virtual circuits in the Flow_Control_Ready state (d1).

The action taken by the DCE when the DTE does not confirm the restart within time-out T10 are given in Appendix D, "DCE Time-outs and DTE Time-limits"

3.3.3 Restart Collision

Restart collision occurs when a DTE and a DCE simultaneously transfer a RESTART_REQUEST and a RESTART_INDICATION packet. When this occurs, the DCE and the DTE will consider the restart to be complete. The DCE will not expect a DTE_RESTART_CONFIRMATION packet and will not transfer a DCE_RESTART_CONFIRMATION packet. The DTE will not transmit nor expect to receive a RESTART_CONFIRMATION packet. However, if the procedures in § 3.3.5 are used, then the DTE must determine whether the Restarting Cause Field in the RESTART_INDICATION packet indicates "DTE originated." If so, then the DTE must take no other action except to transmit another RESTART_REQUEST packet after some randomly-chosen time delay.

IBM SNA X.25 DTEs do not expect a DCE_RESTART_CONFIRMATION packet and do not transfer a DTE_RESTART_CONFIRMATION packet when a restart collision occurs. This places all logical channels used for virtual calls in the Ready state (p1), and all logical channels used for permanent virtual circuits in the Flow_Control_Ready state (d1).

3.3.4 Restart Confirmation

When a DTE is prepared to acknowledge a restart, it transmits across the interface a RESTART_CONFIRMATION packet. At this time, the restarting procedure is considered completed.

Having initiated a restarting procedure, the DTE considers the restarting procedure completed when it receives a RESTART_CONFIRMATION packet.

When the restarting procedure is completed, each Virtual Call logical channel is in the Ready state (p1) whereas each Permanent Virtual Circuit logical channel is in the Flow_Control_Ready state (d1).

In a network environment, the RESTART_CONFIRMATION packet received from a DCE can only be interpreted universally as having local significance.

3.3.5 Determining "DTE" or "DCE" Characteristics

This section describes how the restart procedure can be used to determine whether the DTE acts as a DCE or maintains its role as a DTE with respect to logical channel selection during Virtual Call establishment and resolution of Virtual Call collision.

When prepared to initialize the Packet Layer, the DTE must initiate the restart procedure (i.e., transmit the RESTART_REQUEST packet). The determination is based on the response received from the DCE/remote DTE, as outlined below.

a) When the DTE receives a RESTART_INDICATION packet with a restarting cause code that is not "DTE-Originated" (i.e., it came from a DCE), then the DTE must follow the procedures in §§ 4.2, 4.3, and 4.4 as appropriate and maintain its role as a DTE.

b) If the DTE receives a RESTART_INDICATION packet with a restarting cause code of "DTE-Originated" (i.e., it came from another DTE) and it does not have an unconfirmed RESTART_REQUEST packet outstanding (i.e., no restart collision), then the DTE must confirm the restart (as in § 4.4) and act as a DCE.

c) If the DTE receives a RESTART_INDICATION packet with a restarting cause code of "DTE-Originated" (i.e., it came from another DTE) and it does have an unconfirmed RESTART_REQUEST packet outstanding (i.e., a restart collision), the DTE must consider this restart procedure completed (as in § 4.3) but must take no other action except to transmit another RESTART_REQUEST packet after some randomly-chosen time delay.

d) If the DTE issues a RESTART_REQUEST packet that is subsequently confirmed with a RESTART_CONFIRMATION packet (as in § 4.4), then the DTE must maintain its role as a DTE.

Note:

If a DTE operates only in a DTE/DCE environment or a DTE/DTE environment where, by administration, the roles can be predetermined and fixed, then the procedures discussed above are not needed. In these cases, the DTE may be initialized to act in the appropriate manner.

3.4 Error Handling

Table C-1 specifies the reaction of the DCE when special error conditions are encountered. Other error conditions are discussed in § 4.0. Table I-1 in Appendix I, "Description of DTE Packet Layer Actions" specifies the reaction of IBM SNA X.25 DTE when special error situations are encountered.

3.4.1 Diagnostic Packet

The DIAGNOSTIC packet is applicable to both DTE/DCE and DTE/DTE environments. However, in the former, only a DCE may transmit a DIAGNOSTIC packet. In a DTE/DTE environment, a DTE may transmit a DIAGNOSTIC packet only if it's generation can be suppressed when connected to a network.

The DIAGNOSTIC packet is used by some networks to indicate error conditions under circumstances where the usual methods of indication (i.e., reset, clear and restart with cause and diagnostic) are not appropriate (see Tables C-1 and D-1). The DIAGNOSTIC packet from the DCE supplies information on error situations that are considered to be unrecoverable at the packet layer of CCITT Recommendation X.25; the information provided in the Diagnostic Code and Diagnostic Explanation fields of DIAGNOSTIC packets permit an analysis of the error and recovery by higher layers at the DTE if desired or possible. The contents of Diagnostic Code and Diagnostic Explanation fields of DIAGNOSTIC packets must be reported to a higher layer in the DTE. No state transition takes place on the logical channel to which the DIAGNOSTIC packet is related.

A DIAGNOSTIC packet is issued only once per particular instance of an error condition. No confirmation is required to be issued by the DTE on receipt of a DIAGNOSTIC packet. After issuing a DIAGNOSTIC packet, the DCE maintains the logical channel to which the DIAGNOSTIC packet is related in the same state as that when the DIAGNOSTIC packet was generated.

3.4.2 Nonreceipt of window-rotation information

The procedures described in this section may optionally be implemented by a DTE to recover from nonreceipt of window-rotation information (i. e., nonreceipt of a Pr to rotate the window after transmission of DATA packets). It is strongly recommended that a higher layer protocol be used to effect such recovery rather than these procedures.

Nonreceipt of window-rotation information from the viewpoint of the DTE transmitting the DATA packets can occur because of situations such as:

a) loss of transmitted DATA packets, up to an entire window's worth of DATA packets (in the event that such a loss occurs, the transmitting DTE will not receive packets that rotate the window);

b) loss of a packet containing a Pr that rotates the window (packets used for conveying a Pr are RR, RNR, DATA, and REJECT (if subscribed to) packets);

c) less than a full window's worth of DATA packets with the D-bit set to 0 was transmitted (the DCE (or DTE if DTE/DTE), under normal circumstances, is only required to effect window rotation to meet the throughput class and to acknowledge DATA packets with the D-bit set to 1); and

d) the DCE (or DTE if DTE/DTE) is effecting flow control by allowing the window to close (i. e., without sending an RNR packet) when receiving DATA packets with the D-bit set to 0 because of a temporary lack of resources or other reasons.

Failure to receive window-rotation information, depending on the reason, can lead to a condition in which the transmitting DTE is "flow-control inhibited" at the packet layer. If the window has closed, then the transmitting DTE may not transmit any more DATA packets because of the flow-control mechanisms defined in "Flow Control" on page 4-14. The DTE remains flow-control inhibited until its transmission window is rotated and it is not explicitly flow controlled by an RNR packet. Of particular concern are items (a) and (b) above, since the DTE can remain flow-control inhibited indefinitely. This condition is referred to as "flow-control lockout."

3.4.2.1 Optional procedures at the transmitting DTE

To recover from non receipt of window-rotation information, a DTE may start a Window Rotation Timer (T25) when a DATA packet is transmitted across the interface. When a Pr is received that rotates the window, the timer is restarted if there are any previously-transmitted DATA packets still in the window or if additional DATA packets are then transmitted; otherwise, the timer is cancelled. If a Pr that rotates the window is not received before expiration of T25, then the transmitting DTE should reset the logical channel. When resetting the logical channel, the DTE indicates the cause as "DTE Originated" with the diagnostic "Timer Expired Or Retransmission Count Surpassed For DATA Packet Transmission".

Note:

A DCE or DTE receiving DATA packets is not obligated to rotate the window in such a timely fashion so as to prevent the transmitting DTE's T25 timer from expiring (for example, see items (c) and (d) of section 3.4.2). Therefore, the procedure outlined above should be used with caution.

3.4.2.2 Optional procedures at the receiving DTE

To decrease the probability of a lost window-rotation indication packet, the DTE may send a RR. RNR, DATA, or REJECT (if subscribed to) packet every T24 time units (i. e., at the expiration of the Window Status Transmission Timer) while the logical channel is in the FLOW CONTROL READY state (d1). If T24 units have elapsed since the last transmission of a window-rotation indication packet, then either an RR or an RNR is sent. The packet that is sent should reflect the current condition of the DTE that transmits it. Thus, if the DTE is unable to accept more DATA packets, then an RNR packet is transmitted; otherwise, an RR packet is transmitted. These packets contain a Pr corresponding to the most recently-received correct DATA packet. This Pr then becomes the lower window edge at the transmitting DTE.

The above procedure does not preclude the use of additional algorithms for rotation of the window. This procedure merely attempts to ensure that once a decision is made to rotate the window, the transmission of that decision will be effected even if the original packet is lost.

Note:

In a DTE/DCE environment, use of the above procedure at one DTE/DCE interface may not have any effect on the other DTE/DCE interface.

3.4.3 Receipt of erroneous DATA packets

The normal operation of data transfer requires that DATA packets be received in sequence, be no larger than the maximum-allowed packet size for the current data transfer operation, and contain an integral number of octets in the User Data Field. Receipt of a DATA packet with a nonconsecutive Ps value (i. e., Ps not equal to Ps+1, modulo 8, or modulo 128 when extended), with a User Data Field length greater than the allowed maximum, or with a User Data Field not octet aligned is considered an error.

Two alternatives are available to a DTE for recovering from the errors described above. They are:

a) ignore the erroneous DATA packet and reset the logical channel with a cause indicating "DTE Originated" and one of the following diagnostics as appropriate:

- Invalid Ps,
- Packet Too Long, or
- Nonoctet Aligned Data Field;

b) ignore the erroneous DATA packet and transmit a REJECT packet with a Pr equal to the Ps expected in the next in-sequence DATA packet.

This alternative may be used only if agreement has been reached on the use of the Packet Retransmission Facility with the interfacing DCE (DTE if DTE/DTE). Furthermore, in a DTE/DCE environment, packet retransmission by a DCE as a result of receiving a REJECT packet only carries local significance. That is, a DCE will respond to the REJECT packet by retransmitting the requested DATA packet across the local interface (a DCE does not transmit a REJECT packet to the remote DTE).

The standard mode of recovery requires that the logical channel be reset.

3.5 Other Considerations

3.5.1 DTE/DTE versus DTE/DCE Operation

For the most part, much of the Packet Layer protocol described herein is independent of whether the DTE is connected to a DCE (i.e., X.25 network environment) or directly to another DTE. However, there are certain procedures within X.25 that are not mandatory of a DTE but are required in a DTE/DTE environment. To minimize the number of differences that arise when considering whether connection is to a DCE or to another DTE, the following procedures are always required of a DTE:

- the Address Length Fields and the Facility Length Field are required in CALL_ACCEPTED packets even if they indicate that no address and facility information, respectively, are present;
- the Diagnostic Code Field in RESTART_REQUEST, CLEAR_REQUEST, and RESET_REQUEST packets must be supplied even if it indicates "No Additional Information" (that is, although specific diagnostics are defined for particular error situations, a DTE may use more general codes as discussed in Note 1 of Table E_1);
- a DATA packet whose User Data Field is less than the maximum allowed and which has D=0 and M=1 should not be transmitted; and
- upon notification that the Data Link Layer has completed its initialization procedures or that it has recovered from a failure in which the Data Link Layer was in the disconnected phase, the DTE must transmit a RESTART_REQUEST packet across the interface.

Still, for a few of the procedures described in the following sections, consideration must be given to whether the DTE is connected to a DCE or another DTE. For a DTE/DTE environment, these considerations are listed below.

- One of the DTEs must act as a DCE for
  - logical channel selection during Virtual Call setup (see Table A-1),
  - resolution of Virtual Call collision (see § 4.1.6).

  (This choice is made independently for each of the DTE's Packet Layer entities.)
- A DTE must be able to accept a RESTART_INDICATION packet with a Restarting Cause of "DTE-Originated", an event which does not occur in a DTE/DCE environment.
- A DTE should not receive a RESTART_, CLEAR_, or RESET_INDICATION packet with a Cause other than "DTE-Originated" (although this may occur in a DTE/DCE environment). Therefore, the DTE may either handle such a packet as it does in a DTE/DCE environment (i.e., process the packet normally) or treat it as an error (DTE/DTE environment only).
- A DTE may transmit a DIAGNOSTIC packet in the appropriate circumstances (see § 3.4.1) only if its generation can be suppressed when connected to a network.
- A DTE may either ignore or treat as an error the receipt of facility codes that do not apply to a DTE/DTE environment.

- Use of the optional On-line_Facility_Registration_Facility (see § 6.1) requires agreement for each direction of registration procedure initiation. That is, for a given direction of registration procedure initiation, agreement to use this facility permits the initiating DTE to transmit REGISTRATION_REQUEST packets and requires the responding DTE to process received REGISTRATION_REQUEST packets. (In a DTE/DCE environment, a DTE will not receive a REGISTRATION_REQUEST packet.

- Use of the optional Packet_Retransmission_Facility (see § 6.4) requires agreement for each direction of DATA packets. That is, for a given direction of transmission of DATA packets, agreement to use this facility permits the destination DTE to transmit REJECT packets and requires the source DTE to process received REJECT packets. (In a DTE/DCE environment, a DTE will not receive a REJECT packet.)

- Use of the optional Fast Select Facility (see § 6.16) must be agreed to by both DTEs prior to transmission of any call setup packets which utilize this facility. (In a DTE/DCE environment, such prior agreement is not required - a DTE may always use this facility at call setup.)

- A called DTE which subscribes to the Flow_Control_Parameter_Negotiation_Facility (see § 6.12) and/or the Throughput_Class_Negotiation_Facility (see § 6.13) will not receive, in an INCOMING_CALL packet, a facility indication from which to negotiate if the calling DTE is satisfied with the default values and, thus has not included the facility request in its CALL_REQUEST packet. In a similar manner, a calling DTE which subscribes to these facilities will not receive, in a CALL_CONNECTED packet, a facility indication if the called DTE is satisfied with the values in the INCOMING_CALL packet and thus has not included a facility request in its CALL_ACCEPTED packet. (In a DTE/DCE environment, these facility indications are always present if the DTE has subscribed to these facilities.)

3.5.2 Operation Over Circuit-Switched Connections

Most communications over a circuit-switched connection are between DTEs that have been arranged, by some prior administrative procedure, to be compatible. Agreement must be reached, for example, as to what logical channels will be used, the window sizes to be used, and a number of other items pertaining to Packet Layer operation. In some cases, however, it may be desirable to allow for random communications, where one DTE accesses another DTE via a circuit-switched connection without prior agreement (for example, an electronic mail-order service). To allow for this, the following subset of the Packet Layer procedures will be used:

- the interface shall consist of a single two-way Virtual Call logical channel using Identifier 1;
- the procedures described in § 3.3.4 are required;
- the default values for all applicable parameters listed in Table D-1 apply; parameters T24, T25, T27, T28, R25, R27, and R28 and the procedures in §§ 6.1 and 6.4 do not apply;
- the reset procedures shall apply if erroneous DATA packets are received; and
- no optional user facilities shall be allowed.

s Extensions beyond this basic set of procedures and capabilities (e.g., through
s the use of the On-line_Facility_Registration_Facility - see § 6.1) are being
s pursued in conjunction with CCITT work on Recommendation X.32

Chapter 4. Procedures for Virtual Circuit Services

Procedures for two types of virtual circuit services are included in CCITT Recommendation X.25 as follows:

1. Virtual Call (Switched Virtual Circuit) services, and
2. Permanent Virtual Circuit services.

4.1 Procedure for Virtual Call Service

Figure B-1 on page B-2, Figure B-2 on page B-3 and Figure B-3 on page B-4 show the state diagrams which define the events at the Packet Layer DTE/DCE interface for each logical channel used for virtual calls.

Appendix C, "Packet Layer DCE Actions" gives details of the action taken by the DCE on receipt of packets in each state shown in Appendix B, "Packet Layer DTE/DCE Interface State Diagrams."

Appendix I, "Description of DTE Packet Layer Actions" gives details of the actions taken by DTEs on receipt of packets in each state shown in Appendix B, "Packet Layer DTE/DCE Interface State Diagrams."

The call set-up and clearing procedures described in the following points apply independently to each logical channel assigned for the Virtual Call service at the DTE/DCE or DTE/DTE interface.

4.1.1 Ready State

If there is no call in existence, a logical channel used for Virtual Calls is in the Ready state (p1).

4.1.2 Call Request Packet

The calling DTE indicates a call request by transferring a CALL_REQUEST packet across the DTE/DCE or DTE/DTE interface and by starting the Call Request Response Timer (T21). The logical channel, selected for the call by the DTE, is then in the DTE_Waiting state (p2). The CALL_REQUEST packet includes the called DTE address.

Notes:

1. A DTE address may be a network address or any other DTE identification agreed upon for a period of time between the DTE and the DCE or remote DTE (DTE/DTE).
2. If the DTE maintains its role as a DTE, then the CALL_REQUEST packet should use the logical channel in the Ready state (r1) with the highest number in the range that has been agreed upon with the network Administration or remote DTE (DTE/DTE) (see Appendix A, "Logical Channel Ranges"). In a DTE/DTE environment, however, if the DTE acts as a DCE for these procedures, then it chooses a logical channel in the READY state (p1) starting at the low end of the range of logical channels. Thus, the risk of call collision is minimized.

The failure to receive a CALL_CONNECTED packet or a CLEAR_INDICATION packet before expiration of timer T21 after transmission of a CALL REQUEST packet is considered an error. The Packet Layer clears the call with a cause indicating "DTE Originated" and the diagnostic "Timer Expired For Call Request."

4.1.3 Incoming Call Packet

The DCE will indicate that there is an incoming call by transferring an INCOMING_CALL packet across the DTE/DCE interface. This places the logical channel, selected for the call by the DCE, in the DCE_Waiting state (p3).

The incoming call packet will use the logical channel in the Ready state with the lowest number (see Appendix A, "Logical Channel Ranges"). The INCOMING_CALL packet includes the calling DTE address. The contents of the called DTE address field are ignored by the packet layer of IBM SNA X.25 DTEs. However, the address information and any data received as part of this packet must be forwarded to a higher layer entity. In addition, optional user facility information may also be passed to a higher layer entity.

Notes:

1. A DTE address may be a DTE network address or any other DTE identification agreed upon for a period of time between the DTE and the DCE.
2. In a DTE/DTE environment, the INCOMING_CALL packet received by one DTE is the same as the CALL_REQUEST packet transmitted by the other DTE.

4.1.4 Call Accepted Packet

The called DTE shall indicate its acceptance of the call by transferring a CALL_ACCEPTED packet specifying the same logical channel as that of the INCOMING_CALL packet, before timer T11 elapses. This places the specified logical channel in the Flow_Control_Ready substate of Data Transfer state (p4).

The decision of whether to accept a call is made by a higher layer entity before a CALL_ACCEPTED packet may be returned by the Packet Layer. Furthermore, it may provide data to be returned to the calling DTE as part of the CALL_ACCEPTED packet. However, a call may be rejected without informing a higher layer entity of its receipt, for reasons local to the Packet Layer (for example, a format error in the INCOMING CALL packet).

Note:

A CALL_ACCEPTED packet is not returned if the INCOMING_CALL packet indicates the Fast_Select_Facility with a restriction on the response.

If the called DTE does not accept a call by a CALL_ACCEPTED packet, or does not reject it by a CLEAR_REQUEST packet as described in § 4.1.7, within time-out T11 (see Appendix D, "DCE Time-outs and DTE Time-limits"), the DCE will consider it is a procedure error on the part of the called DTE and clear the virtual call according to the procedure described in § 4.1.8.

4.1.5 Call Connected Packet

The receipt of a CALL_CONNECTED packet by the calling DTE specifying the same logical channel as that specified in the CALL_REQUEST packet indicates that the call has been accepted by the called DTE by means of a CALL_ACCEPTED packet. This places the specified logical channel in the Flow_Control_Ready substate (D1) of Data Transfer state (p4).

Any address information and any data received as part of the CALL_CONNECTED packet must be forwarded to a higher layer entity. In addition, optional user facility information may also be passed to a higher layer entity.

Note:

A In a DTE/DTE environment, the CALL_CONNECTED packet received by on DTE is the same as the CALL_ACCEPTED packet transmitted by the other DTE.

The time spent in the DTE Waiting state (p2) will not exceed time-limit T21 (see Appendix D, "DCE Time-outs and DTE Time-limits").

4.1.6 Call Collision

Call collision occurs when a DTE transmits a CALL_REQUEST packet and then receives an INCOMING_CALL packet specifying the same logical channel. When this occurs, the DCE will proceed with the CALL_REQUEST and cancel the INCOMING_CALL.

Further action by the DTE is dependent on whether the DTE maintains its role as a DTE or acts as a DCE for resolving call collision.

- If the DTE maintains its role as a DTE, then it should ignore the INCOMING_CALL packet and wait for the response from the DCE/remote DTE. The DTE should receive either a CALL_CONNECTED packet (if the call is accepted by the remote DTE) or a CLEAR_INDICATION packet for the same channel as that in the CALL_REQUEST packet.
- In a DTE/DTE environment, if the DTE acts as a DCE, then it must cancel its call request and decide whether to transmit a CALL_ACCEPTED packet or a CLEAR_REQUEST packet.

IBM SNA X.25 DTEs in a DTE/DCE environment discard the INCOMING_CALL packet in the event of call collision.

4.1.7 Clearing by the DTE

The DTE may indicate call clearing, at any time, by transferring a CLEAR_REQUEST packet across the interface (see § 4.5) and starting the Clear Request Response Timer (T23). The logical channel is then in the DTE_Clear_Request state (p6). In this state, the DTE accepts only CLEAR_CONFIRMATION and CLEAR_INDICATION packets. Other types of packets are ignored by the DTE. Therefore, higher layer entities must be able to cope with the various possible situations that may occur. When the DCE is prepared to free the logical channel, the DCE will transfer a DCE_CLEAR_CONFIRMATION packet specifying the same logical channel across the interface. The logical channel is then in the Ready state (p1).

The DCE_CLEAR_CONFIRMATION packet can only be interpreted universally as having local significance; however, within some Administrations' networks, CLEAR_CONFIRMATION may have end-to-end significance. In all cases, the time spent in the DTE_Clear_Request state (p6) will not exceed time-limit T23 (see Appendix D, "DCE Time-outs and DTE Time-limits"). If a DCE_CLEAR_CONFIRMATION packet is not received before timer T23 expires, the CLEAR_REQUEST packet will be retransmitted after timer T23 is reinitialized. If the total time spent in state (p6) exceeds 'R23' times T23, where 'R23 $\geq$ 1', notification of the clear failure must be given to a higher layer by the DTE using appropriate DTE-Generated Cause and Diagnostic codes (see Appendix H, "DTE-Generated Diagnostic Codes"); the logical channel remains in the DTE_CLEAR_REQUEST state (p6).

The CLEAR_REQUEST packet may contain data provided by a higher layer entity to be sent to the remote DTE. This may be done only if the CALL_REQUEST and INCOMING_CALL packets had indicated the Fast_Select_Facility.

It is possible that subsequent to transferring a CLEAR_REQUEST packet the DTE will receive other types of packets, depending upon the state of the logical channel, before receiving a DCE_CLEAR_CONFIRMATION packet. Any such packets are discarded by IBM SNA X.25 DTEs.

Note:

The calling DTE may abort a call by clearing it before it has received a CALL_CONNECTED or CLEAR_INDICATION packet. In this case, the DTE may not transmit data in the CLEAR_REQUEST packet.

The called DTE may refuse an incoming call by clearing it as described in this point rather than transmitting a CALL_ACCEPTED packet as described in § 4.1.4. The called DTE must provide the reason for refusing an incoming call by placing an appropriate diagnostic code (see Appendix H, "DTE-Generated Diagnostic Codes" on page H-1) in the Diagnostic Code field of the CLEAR_REQUEST packet.

4.1.8 Clearing by the DCE

The DCE will indicate call clearing by transferring a CLEAR_INDICATION packet across the DTE/DCE interface (see § 4.5). The logical channel is then in the DCE_Clear_Indication state (p7). In this state, if the DTE receives any packet other than another CLEAR_INDICATION packet, it discards the packet and transmits a CLEAR_REQUEST packet with a cause indicating "DTE Originated" and a diagnostic "Packet Type Invalid For State p7." The DTE shall respond to the CLEAR_INDICATION packet by transferring a DTE_CLEAR_CONFIRMATION packet, before time-out T13 elapses. The logical channel is then in the Ready state (p1). The clearing cause code, as well as the diagnostic code and an indication that a clearing procedure has taken place is passed to a higher layer entity. Any data and optional user facility information received in the CLEAR_INDICATION packet must also be forwarded to a higher layer entity.

The actions taken by the DCE when a DTE does not confirm a call clearing within time-out T13 are given in Appendix D, "DCE Time-outs and DTE Time-limits."

4.1.9 Clear Collision

A clear collision occurs when a DTE and a DCE simultaneously transfer a CLEAR_REQUEST packet and a CLEAR_INDICATION packet specifying the same logical channel. In this event, the DCE and the DTE will consider that the call clearing is completed. Neither the DTE nor the DCE will expect a CLEAR_CONFIRMATION packet and neither will transfer a CLEAR_CONFIRMATION packet. This places the logical channel in the Ready state (p1).

4.1.10 Unsuccessful Call

If a call cannot be established, the DCE transfers A CLEAR_INDICATION packet specifying the logical channel indicated in the CALL_REQUEST packet. IBM SNA X.25 DTEs must report the contents of network generated call clearing cause and diagnostic code fields to a higher layer.

4.1.11 Call Progress Signals

The DCE will be capable of transferring to the DTE Clearing_Call_Progress signals as specified in CCITT Recommendation X.96.

Clearing_Call_Progress signals will be carried in CLEAR_INDICATION packets which will terminate the call to which the packet refers. The method of coding CLEAR_INDICATION packets containing Call_Progress_Signals is detailed in § 5.2.3. IBM SNA X.25 DTEs must report all clearing Call_Progress_Signals to a higher layer.

4.1.12 Data Transfer State

The procedures for the control of packets transferred between a DTE and a DCE in the Data_Transfer state (p4) are described in "Procedures for Data [and Interrupt] Transfer" on page 4-6.

4.2 Procedures for Permanent Virtual Circuit Service

Figure B-1 on page B-2 and Figure B-4 on page B-5 show the state diagrams which give a definition of events at the packet layer DTE/DCE interface for logical channels assigned for permanent virtual circuits.

Appendix C, "Packet Layer DCE Actions" gives details of the action taken by DCEs on receipt of packets in each state shown in Appendix B, "Packet Layer DTE/DCE Interface State Diagrams."

Appendix I, "Description of DTE Packet Layer Actions" gives details of the action taken by the DTE upon receipt of packets in each state shown in Appendix B, "Packet Layer DTE/DCE Interface State Diagrams."

For permanent virtual circuits there is no call set-up or clearing. Procedures for the control of packets transferred between the DTE and DCE while in the Data_Transfer state (p4) are described in "Procedures for Data [and Interrupt] Transfer" on page 4-6.

If a momentary failure occurs within the network, the DCE will reset the permanent virtual circuit as described in § 4.4.3, with the cause "Network Congestion," and then will continue to handle data traffic.

If the network has a temporary inability to handle data traffic, the DCE will reset the permanent virtual circuit with the cause "Network Out-of-Order." When the network is again able to handle data traffic, the DCE should reset the permanent virtual circuit with the cause "Network Operational."

4.3 Procedures for Data [and Interrupt] Transfer

The data transfer [and interrupt] procedures described in this section apply independently to each logical channel assigned for virtual calls and permanent virtual circuits existing at the DTE/DCE or DTE/DTE interface.

Normal network operation dictates that user data in data [and interrupt] packets are all passed transparently, unaltered, either directly or through the network in the case of packet DTE to packet DTE communications. Order of bits in DATA and [INTERRUPT] packets is preserved. Packet sequences are delivered as complete packet sequences. DTE Diagnostic Codes are treated as described in §§ 5.2.3, 5.4.3 and 5.5.1.

4.3.1 States for Data Transfer

A virtual call logical channel is in the Flow Control Ready substate (d1) of Data Transfer state (p4) after completion of call establishment and prior to a clearing or a restarting procedure. A permanent virtual circuit logical channel is continually in the Flow Control Ready substate (d1) of Data Transfer state (p4) except during a reset or restart procedure. DATA, [INTERRUPT,] flow control, REJECT (if subscribed to), and reset packets may be transmitted and received across the interface in the Data Transfer state (p4) of a logical channel. In this state, the flow control and reset procedures described in § 4.4 apply to data transmission on that logical channel to and from the DTE.

When a virtual call is cleared, DATA and [INTERRUPT] packets may be discarded by the network (see § 4.5). In addition, DATA, [INTERRUPT,] flow control, REJECT (if subscribed to),
and reset packets transmitted by the DTE will be ignored by the DCE when the logical channel is in the DCE_CLEAR_INDICATION state (p7). Hence, it is left to the DTE to define DTE to DTE protocols able to cope with the various possible situations that may occur.

4.3.1.1 SNA-to-SNA Connections

Logical Link Control (LLC, see Chapter 8, "Logical Link Control (LLC) on SNA-to-SNA Connections") protocols enable IBM SNA X.25 DTEs to cope with the various situations that may possibly occur on SNA-to-SNA connections.

The following actions are taken by IBM SNA X.25 DTEs to protect against possible packet losses:

- Orderly Clearing

  Virtual call clearing is normally initiated only upon requests from SNA control points which are responsible for making sure that data flows have first been quiesced and all sessions using the virtual circuit have been properly deactivated.

- Accidental Clearing

When call clearing is initiated by the network, following some network detected error condition, the station is placed in an inoperative state and notification of the station outage is given to a higher layer causing session outage notifications to be propagated according to SNA mechanisms to all half-sessions that were sharing the virtual circuit. Inoperative stations are returned to an operational state only by stimulus from a higher layer SNA protocol. After the station is recontacted and sessions are reestablished the SNA session protocols are responsible for recovery from any packet loss that may have occurred as a result of call clearing.

Note:

Some early IBM SNA X.25 DTE implementations use a Physical Services Header (PSH - see Appendix J, "Physical Services Headers") instead of the QLLC described in Appendix O, "Description of the BNN_Qualified Logical Link Control - (QLLC) Procedures."

4.3.2 User_Data Field Length of Data Packets

The standard maximum User_Data field length is '128' octets.

In addition, other maximum User_Data field lengths that may be offered by Administrations include:

'16', '32', '64', '256', '512', '1024' '2048' and '4096' octets.

An optional maximum User_Data field length may be selected for a period of time as the default maximum User_Data field length common to all virtual calls at the interface (see § 6.9). A value other than the default may be selected for a period of time for each permanent virtual circuit (see § 6.9). Negotiation of maximum User_Data field lengths, on a per call basis, may be made with the Flow_Control_Parameter_Negotiation facility (see § 6.12).

IBM SNA X.25 DTE implementations that allow maximum User_Data field lengths other than '128' octets support the Flow_Control_Parameter_Negotiation facility (i.e., not all networks provide the selection of a default maximum length other than '128' octets). As a result, a multi-channel interface may be required to simultaneously support multiple maximum packet lengths.

The User_Data field of DATA packets transmitted across the interface may contain any number of octets up to the agreed maximum.

Note:

Some networks require the User_Data field to contain an integral number of octets (see § 3.0, Note 1).

If the User_Data field in a DATA packet exceeds the locally permitted maximum User_Data field length, then the DCE will reset the virtual call or permanent virtual circuit with the resetting cause "Local_Procedure_Error." Upon receipt of a reset on a virtual call logical channel, IBM SNA X.25 DTEs clear the virtual call and must report the error to a higher layer.

When IBM SNA X.25 DTEs receive DATA packets that exceed the locally permitted maximum User_Data field length, they clear the virtual call or reset the permanent virtual circuit with appropriate Cause and Diagnostic codes (see Appendix H, "DTE-Generated Diagnostic Codes") and must report the error to a higher layer. To be in compliance with ISO 8208 or ANS X3.100, the DTE must reset the virtual call or permanent virtual circuit upon receipt of a DATA packet that exceeds the locally permitted maximum User_Data field length.

4.3.3 Delivery Confirmation (D) Bit

4.3.3.1 SNA-to-SNA Connections

The value of the 'D' bit in packets on SNA-to-SNA connections should always be '0'. When IBM SNA X.25 DTEs receive a DATA packet that contains 'D=1', they clear the virtual call or reset the permanent virtual circuit with appropriate Cause and Diagnostic codes (see Appendix H, "DTE-Generated Diagnostic Codes") and must report the error to a higher layer.

Upon receipt of an INCOMING_CALL or CALL_CONNECTED packet with 'D=1', IBM SNA X.25 DTEs clear the virtual call with appropriate Cause and Diagnostic codes (see Appendix H, "DTE-Generated Diagnostic Codes") and report the error to a higher layer of SNA.

4.3.3.2 SNA-to-non_SNA Connections

The setting of the Delivery Confirmation bit (D-bit) is used to indicate whether or not the DTE wishes to receive an end-to-end acknowledgement of delivery, for data it is transmitting, by means of the packet receive sequence number (Pr) (see § 4.4).

Note:

Use of the D-bit procedure does not obviate the need for a higher layer protocol agreed upon between participating DTEs which may be used with or without the D-bit procedure to recover from user or network generated resets and clearings.

The calling DTE may, during call establishment, ascertain that the D-bit procedure can be used for the call by setting bit 7 in the General Format Identifier of the CALL_REQUEST packet to '1' (see § 5.1.1). Every network or part of the international network will pass this bit transparently. If the called DTE is able to handle the D-bit procedure, it should not regard this bit being set to '1' in the INCOMING_CALL packet as invalid. To be in compliance to ISO 8208, if the DTE is unwilling to use the D-bit procedure and receives a DATA packet with the D-bit set to 1, then it should reset the logical channel with a cause indicating "DTE Originated" and the diagnostic "D_bit Procedure Not Supported."

Similarly, the called DTE can set bit 7 in the General Format Identifier of the CALL_ACCEPTED packet to '1'. Every network or part of international network will pass this bit transparently. If the calling DTE is able to handle the D-bit procedure, it should not regard this bit being set to '1' in the CALL_CONNECTED packet as invalid.

The use by DTEs of the above mechanism in CALL_REQUEST and CALL_ACCEPTED packets is recommended but is not mandatory for using the D-bit procedure on virtual calls.

Some DTEs may request either local or remote significance and some IBM SNA X.25 DTEs may permit partner DTEs to operate with end-to-end significance. Thus, bit 7 of the first octet (GFI) in CALL_REQUEST and CALL_ACCEPTED packets may be set to '0' or '1' according to the parameters that, in the SNA "BIND" command opening the SNA session corresponding to the virtual circuit, indicate whether definite responses are supported for that SNA session (see Approach 1 in Appendix K, "SNA-to-non_SNA Architectural Considerations")

Similarly, the state of bit 7 of the first octet (GFI) in INCOMING_CALL packets may be used to determine the proper "BIND" protocol. The state of bit 7 of the first octet in CALL_CONNECTED packets may be compared to the established SNA session and a decision made as to whether compatibility of operation on the virtual circuit and the SNA session is guaranteed.

4.3.4 More Data Mark

If a DTE or DCE wishes to indicate a sequence of more than one packet, it uses a More Data mark (M-bit) as defined below.

4.3.4.1 SNA-to-SNA Connections

M-bit segmenting is required for IBM SNA X.25 DTEs, but if compatibility with the IBM 5973 NIA is required, the PSH segmenting procedure described in Appendix J, "Physical Services Headers" must be implemented as well.

When PSH segmenting is implemented, the maximum packet size must be the same at the local and remote X.25 DTE/DCE interfaces.

'M=1' is only used in full data packets to indicate that more data follows. Recombination with the following data packet may only be performed within the network when 'M=1'.

Upon receipt of a partially filled DATA packet with 'M = 1', IBM SNA X.25 DTEs on SNA-to-SNA connections clear the virtual call or reset the permanent virtual circuit with appropriate Cause and Diagnostic codes (see Appendix H, "DTE-Generated Diagnostic Codes").

4.3.4.2 SNA-to-non_SNA Connections

The M-bit can be set to '1' in any DATA packet except in a partially full DATA packet carrying the D-bit set to zero. 'M=1' in a full DATA packet or in a partially full DATA packet that also has 'D=1', indicates that more data follows. Recombination with the following DATA packet may only be performed within the network when 'M=1' in a full DATA packet that also has 'D=0'.

A sequence of DATA packets with 'M = 1' in every packet except for the last one will be delivered as a sequence of DATA packets with 'M=1' in every packet except for the last one when the original packets having 'M=1' are either full (irrespective of the setting of the D-bit) or partially full but have 'D=1'.

Two categories of data packets, 'A' and 'B', are defined as shown in Table 15. Table 15 also illustrates the network's treatment of the M-bit and the D-bit at both ends of virtual calls or permanent virtual circuits. A DTE should not transmit a partially full DATA packet with the M-bit set to 1 and the D-bit set to 0. Upon receipt of such a packet, the DTE (even if acting as a DCE in a DTE/DTE environment) should reset the logical channel.

Table 15: Definition of Two Categories of DATA Packets and Network Treatment of the M-bit and the D-bit

Data packet sent by source DTE				Combining with subsequent packet(s) is performed by the network when possible	Data Packet* Received by Destination DTE	
Category	M	D	Full		M	D
B	0 or 1	0	No	No	0 (1)	0
B**	0	1	No	No	0	1
B**	1	1	No	No	1	1
B	0	0	Yes	No	0	0
B**	0	1	Yes	No	0	1
A	1	0	Yes	Yes (2)	1	0
B**	1	1	Yes	No	1	1

* - Refers to the delivered data packet whose last bit of user data corresponds to the last bit of user data, if any, that was present in the data packet sent by the source DTE.
** - Valid on SNA-to-non_SNA connections only.

Notes with reference to Table 15:

1. The originating network will force the M-bit to '0'.
2. If the DATA packet sent by the source DTE is combined with other packets, up to and including a category 'B' packet, the M-bit and the D-bit settings in the DATA packet received by the destination DTE will be according to that given in the right hand columns for the last DATA packet sent by the source DTE that was part of the combination.

4.3.5 Complete Packet Sequence

A complete packet sequence is defined as being composed of a single category 'B' packet and all contiguous preceding category 'A' packets (if any). Category 'A' packets have the exact maximum User_Data field length with 'M=1' and 'D=0'. All other DATA packets are category 'B' packets.

When transmitted by a source DTE, a complete packet sequence is always delivered to the destination DTE as single complete packet sequence.

Thus, if the receiving end has a larger maximum User_Data field length than the transmitting end, then packets within a complete packet sequence will be combined within the network. They will be delivered in a complete packet sequences where each packet, except the last one, has the exact maximum User_Data field length, 'M=1' and 'D=0'. The User_Data field of the last packet of the sequence may have less than the maximum length and the M-bit and the D-bit set as described in Table 15.

If the maximum User_Data field length is the same at both ends, then User_Data fields of DATA packets are delivered to the receiving DTE exactly as received by the network, except as follows. If a full packet with 'M=1' and 'D=0' is followed by an empty packet, the two packets may be merged so as to become a single category 'B' full packet. If the last packet of a complete packet sequence transmitted by the source DTE has a User_Data field less than the maximum length with 'M = 1' and 'D = 0' (which a DTE is not permitted to send), the last packet of the complete packet sequence is delivered to the destination DTE with 'M=0'.

If the receiving end has a smaller maximum User_Data field length than the transmitting end, the packets will be segmented within the network, and the M-bit and the D-bit set by the network as described to maintain complete packet sequences.

4.3.5.1 SNA-to-SNA Connections Only

When PSH segmenting is used, the maximum packet length at the local and remote DTE/DCE interfaces is the same. Therefore, no 'M' bit packet sequences occur at either DTE/DCE interface.

4.3.6 Qualifier Bit

In some cases, an indicator may be needed with the User_Data field to distinguish between two types of information. It may be necessary to differentiate, for example, between User_Data and control information. An example of such a case is contained in CCITT Recommendation X.29.

If such a mechanism is needed, an indicator in the DATA packet header, called the Qualifier bit (Q-bit), may be used.

The use of the Q-bit is optional. If this mechanism is not needed, the Q-bit is always set to '0'. If the Q-bit mechanism is used, the transmitting DTE should set the Q-bit so as to have the same value (i.e., '0' or '1') in all DATA packets of the same complete packet sequence. The setting of the Q-bit in a complete packet sequence is determined from instructions received from a higher layer entity. Likewise, the setting of the Q-bit for each complete packet sequence received is passed to a higher layer entity. A complete packet sequence transferred by the DTE to the DCE in this fashion will be delivered to the distant DTE as a complete packet sequence having the Q-bit set in all packets to the value assigned by the transmitting DTE.

If the Q-bit is not set by the DTE to the same value in all the DATA packets of a complete packet sequence, the value of the Q-bit in any of the DATA packets of the corresponding packet sequence transferred to the distant DTE is not guaranteed by the network. Moreover, some networks may reset the virtual call or permanent virtual circuit as described in Appendix C, "Packet Layer DCE Actions."

Other sequences of Q-bit settings received cause IBM SNA X.25 DTEs to reset the permanent virtual circuit or clear the virtual call with appropriate Cause and Diagnostic codes (see Appendix H, "DTE-Generated Diagnostic Codes"). IBM SNA X.25 DTEs must report the contents of the resetting/clearing cause and diagnostic code fields to a higher layer. To be in compliance with ISO 8208, the action taken by a DTE when the Q-bit is not set to the same value in all DATA packets received in a complete packet sequence is to reset the logical channel with a cause indicating "DTE Originated" and the diagnostic "Inconsistent Q-bit Settings".

Successive DATA packets are numbered consecutively (see § 4.4.1.1) regardless of the value of the Q-bit.

4.3.6.1 SNA-to-SNA Connections

The Q-bit is used by IBM SNA X.25 DTEs on SNA-to-SNA connections to identify DATA packets associated with the QLLC procedure described in § 8.0.

4.3.6.2 SNA-to-non_SNA Connections

CCITT Recommendation X.29 provides one example of the procedures to be used when the Q-bit is set to '1'. IBM SNA X.25 DTEs that support CCITT Recommendation X.29 and other packet assembly/disassembly (PAD) control procedures implement the Q-bit procedure, accordingly.

4.3.7 Interrupt Procedure

4.3.7.1 SNA-to-SNA Connections

The interrupt procedure is not permitted on SNA-to-SNA connections. IBM SNA X.25 DTEs clear the virtual call or reset the permanent virtual circuit with the Diagnostic, "Not Supported," #170 (x'AA') upon receipt of a DCE_INTERRUPT or DCE_INTERRUPT_CONFIRMATION packet.

4.3.7.2 SNA-to-non_SNA Connection

The interrupt procedure allows a DTE to transmit data to the remote DTE, without following the flow control procedures applying to DATA packets (see § 4.4). The initiation of the interrupt procedure and the generation of the data are controlled by a higher layer entity. Upon receipt of an INTERRUPT packet, a signal indicating that an interrupt has occurred, along with the data, is passed to a higher layer entity. The interrupt procedure can only apply during the Flow_Control_Ready state (d1) within the Data_Transfer state (p4). Therefore, the interrupt procedure is abandoned as a result of a clearing (Virtual Calls only), reset, or restart procedure. Within state d1, there are four states (two for each direction of interrupt transmission) that apply to the interrupt procedure. They are the DTE_Interrupt_Ready (i1), DTE_Interrupt_Sent (i2), DCE/remote DTE_Interrupt_Ready (j1), DCE/remote DTE_Interrupt_Sent (j2) states. Table I-5 specifies the action taken by the DTE on the receipt of interrupt packets from the DCE/remote DTE as applied to the interrupt procedure.

The interrupt procedures have no effect on the transfer and flow control procedures applying to the DATA packets on the virtual call or permanent virtual circuit. For a given Virtual Call or Permanent Virtual Circuit, an INTERRUPT packet is delivered at or before the point in the stream of DATA packets at which the interrupt was generated. It must be processed as soon as it is received.

An INTERRUPT packet may contain up to 32 octets of user data. If the User_Data Field in an INTERRUPT packet exceeds 32 octets or if it is nonoctet aligned, then the receiving DTE will invoke the reset procedure.

Prior to transmitting an interrupt, the logical channel is in the DTE_Interrupt_Ready state (i1). To transmit an interrupt, a DTE transfers a DTE_INTERRUPT packet across the interface and starts the Interrupt Response

Timer (T26). At this time, the logical channel is in the DTE_Interrupt_Sent state (i2). Failure to receive an INTERRUPT_CONFIRMATION packet before expiration of T26 after transmission of an INTERRUPT packet is considered an error. In this case, the DTE resets the logical channel with a cause indicating "DTE Originated and the diagnostic "Timer Expired for Interrupt." The DTE should not transmit a second DTE_INTERRUPT packet until the first one is confirmed with a DCE_INTERRUPT_CONFIRMATION packet (see Table C-4). The DCE, after the interrupt procedure is completed at the remote end, will confirm receipt of the interrupt by transferring DCE_INTERRUPT_CONFIRMATION packet. Receipt of a DCE_INTERRUPT_CONFIRMATION packet indicates that the interrupt has been confirmed by the remote DTE by means of a DTE_INTERRUPT_CONFIRMATION packet.

The DCE indicates an interrupt from remote DTE by transferring DCE_INTERRUPT packet containing the same DATA field as in the DTE_INTERRUPT packet transmitted at the remote DTE. The DTE will confirm receipt of the DCE_INTERRUPT packet by transferring a DTE_INTERRUPT_CONFIRMATION packet.

Prior to receiving an interrupt, the logical channel is in the DCE/remote DTE_Interrupt_Ready state (j1). When a DTE receives an INTERRUPT packet from the DCE/remote DTE, the logical channel is in the DCE/remote DTE_Interrupt_Sent state (j2). In this state, receipt of a subsequent INTERRUPT packet before confirming the prior INTERRUPT packet is considered an error. In this case, the DTE resets the logical channel with a cause indicating "DTE Originated" and the diagnostic "Unauthorized Interrupt."

The Packet Layer passes an indication of the interrupt and the Interrupt User_Data to a higher layer entity.

A DTE confirms receipt of an INTERRUPT packet as soon as possible by transmitting across the interface an INTERRUPT_CONFIRMATION packet. At this time, the logical channel is in the DTE/remote DTE_Interrupt_Ready state (j1).

When a DTE, having previously transmitted an INTERRUPT packet, receives an INTERRUPT_CONFIRMATION packet, the logical channel is in the DTE_Interrupt_Ready state (i1). At this time, the DTE may transmit a subsequent INTERRUPT packet across the interface.

4.3.8 Transit Delay of DATA Packets

Transit delay is an inherent characteristic of a virtual call or a permanent virtual circuit, common to the two directions of transmission.

This transit delay is the data packet transfer delay as defined in § 3.1 of Recommendation X.135, measured between boundaries B2 and Bn-1, as defined in Figure 2 of Recommendation X.135 (that means, excluding the access lines), with the conditions given in § 3.2 of CCITT Recommendation X.135, and is expressed in terms of a mean value.

Selection of transit delay on a per call basis, and indication to both the calling and called DTEs of the value of transit delay applying for a given virtual call, may be made by the means of the transit delay selection and Indication facility (see § 6.28).

4.3.9 Fragmentation and Reassembly of Messages

The Packet Layer provides the service of transmitting messages (also referred to as M-bit sequences) between peer higher layer entities. In a source DTE, the Packet Layer fragments (i.e., packetizes) a message into the appropriate number of DATA packets and sets the D-bit, M-bit, and Q-bit for each resulting packet. This process must take into account the maximum User_Data Field length allowed for the logical channel, the length and Q-bit setting for each complete packet sequence contained in the message, and whether end-to-end acknowledgement is requested, then the D-bit is set to 1 in the last DATA packet of the message. (The D-bit is used only on a SNA-to-non SNA connection.)

Note:

It is permissible to fragment a message in such a way that results in a DATA packet containing a User_Data Field of zero length, however, it is recommended that IBM DTEs not transmit such packets.

4.4 Procedures for Flow Control

This section (§ 4.4) only applies to the Data_Transfer state (p4) and specifies the procedures covering flow control of DATA packets and reset packets on each logical channel used for a virtual call or permanent virtual circuit. The flow control procedure can apply only in the Flow_Control_Ready state (d1). Therefore, the flow control procedure is abandoned as a result of a clearing (Virtual Calls only), reset, or restart procedure. Within state d1, there are four states (two for each direction of flow control) that apply to the flow control procedure. They are the DCE_Receive_Ready (f1), DCE_Receive_Not_Ready (f2), DTE_Receive_Ready (g1), and DTE_Receive_Not_Ready (g2) states. Table I-6 specifies the action taken by the DTE on the receipt of flow control, DATA, and REJECT (if subscribed to) packets as applied to the flow control procedure.

The flow control procedure has no effect on the procedures applying to INTERRUPT packets on a Virtual Call or Permanent Virtual Circuit.

4.4.1 Flow Control

At the DTE/DCE or DTE/DTE interface of a logical channel used for a virtual call or permanent virtual circuit, the transmission of DATA packets is controlled separately for each direction of transmission and is based on authorizations from the receiver.

On a virtual call or permanent virtual circuit, flow control also allows a DTE to limit the rate at which it accepts packets across the interface, noting that there is a network-dependent limit on the number of DATA packets that can be in the network on the virtual call or permanent virtual circuit.

4.4.1.1 Numbering of Data Packets

Each DATA packet transmitted across the interface for each direction of transmission on a virtual call or permanent virtual circuit is sequentially numbered.

The sequence numbering scheme of the packets is performed modulo '8'. The packet sequence numbers cycle through the entire range '0' to '7', inclusively. Some Administrations provide the Extended_Packet_Sequence_Numbering facility (see § 6.2) which, if selected, provides a sequence numbering scheme for packets being performed modulo '128'. In this case, packet sequence numbers cycle through the entire range '0' to '127', inclusively. The packet sequence numbering scheme, modulo '8' or '128', is the same for both directions of transmission and applies for all logical channels at the interface.

Note:

> All IBM SNA X.25 DTEs must implement Modulo '8' packet sequence numbering. Implementation of modulo '128' packet sequence numbering is a product option.

Only DATA packets contain this sequence number called the packet send sequence number, Ps.

The first DATA packet transmitted across the interface for a given direction of data transmission, when the logical channel has just entered the Flow_Control_Ready state (d1), has 'Ps=0'. Subsequent DATA packets are numbered consecutively.

4.4.1.2 Window Description

At the DTE/DCE or DTE/DTE interface, a window is defined for each direction of data transmission, of a logical channel used for a virtual call or permanent virtual circuit. The window is the ordered set of 'W' consecutive packet send sequence numbers of the DATA packets authorized to cross the interface.

The lowest sequence number in the window is referred to as the lower window edge. When a virtual call or permanent virtual circuit at the interface has just entered the Flow_Control_Ready state (d1), the window related to each direction of data transmission has a lower window edge equal to '0'.

The Ps of the first DATA packet not authorized to cross the interface is the value of the lower window edge plus 'W' (modulo '8', or '128' when extended).

The standard window size, 'W', is two (2) for each direction of data transmission at the DTE/DCE interface. In addition, other window sizes may be offered by Administrations. An optional window size may be selected for a period of time as the default window size common to all virtual calls at the interface (see § 6.10). A value other than the default may be selected for a period of time for each permanent virtual circuit (see § 6.10). Negotiation of window sizes, on a per call basis, may be made with the Flow_Control_Parameter_Negotiation facility (see § 6.12).

All IBM SNA X.25 DTEs must implement 'W = 2' and also allow values other than 'W = 2', namely, 'W < modulus' to be set as determined at subscription time. When the access link to the network exhibits long delay characteristics and the packets used are short, IBM SNA X.25 DTEs may implement the optional Flow_Control_Parameter_Negotiation facility as not all networks permit selection of default values other than 'W = 2'.

4.4.1.3 Flow Control Principles

When the Ps of the next DATA packet to be transmitted by the station (DTE or DCE) is within the window, the station is authorized to transmit this DATA packet to the remote station. When the Ps of the next data packet to be transmitted is outside of the window the station will not transmit a DATA packet to the remote station. The remote station should follow the same procedure.

When the Ps of the DATA packet received by the station is the next in-sequence and is within the window, the station will accept the DATA packet. A received DATA packet containing a Ps that is out of sequence (i.e., there is a duplicate or a gap in the Ps numbering), outside the window or not equal to '0' for the first DATA packet received after entering the Flow_Control_Ready state (d1) is considered by the station to be a local procedure error. In a DTE/DCE environment, a DCE will reset the logical channel (see § 4.4.3) with a cause indicating "Local Procedure Error". A DTE will reset the logical channel with a cause indicating "DTE-Originated". In either case, the diagnostic will be "Invalid Ps." IBM SNA X.25 DTEs must report the resetting Cause and Diagnostic Code to a higher layer. Because packets should never get out of order on SNA-to-SNA connections (packet layer retransmission does not occur), an out-of-sequence Ps should be treated as an error.

A number modulo '8' (or '128' when extended), referred to as a packet receive sequence number (Pr), conveys across the interface information from the receiver for the transmission of DATA packets. When transmitted across the interface a Pr becomes the lower window edge. In this way, additional DATA packets are authorized by the receiver to cross the interface.

The Pr is conveyed in DATA, RECEIVE_READY (RR), RECEIVE_NOT_READY (RNR), and REJECT (if subscribed to) packets.

The value of a Pr received must be within the range from the last Pr received by the station up to and including the Ps of the next DATA packet to be transmitted by the station. Otherwise, the station will consider the receipt of this Pr as a procedure error and reset the virtual call or permanent virtual circuit. IBM SNA X.25 DTEs consider the receipt of a Pr value that is not within the range from the last Pr received up to and including the Ps of the next DATA packet to be transmitted as a DCE failure and reset the virtual circuit with appropriate Cause and Diagnostic codes (see Appendix H, "DTE-Generated Diagnostic Codes").

The Pr is less than or equal to the sequence number of the next expected DATA packet and implies that the DTE or DCE transmitting the Pr has accepted <u>at least</u> all DATA packets numbered up to and including 'Pr-1'.

4.4.1.4 Delivery Confirmation

When 'D = 0' in a DATA packet having 'Ps=p', the significance of the returned Pr corresponding to that DATA packet (i.e., 'Pr $\geq$ p + 1') is a local updating of the window across the packet layer interface so that the achievable throughput is not constrained by the round-trip DTE-to-DTE delay across the network (s).

In a DTE/DCE environment, when 'D = 0' in a DATA packet, the returned Pr corresponding to that DATA packet does not signify that a Pr has been received by the remote DTE.

1. SNA-to-SNA Connections

   'D = 1' is not allowed on SNA-to-SNA connections. If a packet with 'D = 1' is received on an SNA-to-SNA connection, IBM SNA X.25 DTEs clear the virtual call or reset the permanent virtual circuit with appropriate Cause and Diagnostic codes (see Appendix H, "DTE-Generated Diagnostic Codes").

   If an INCOMING_CALL or CALL_CONNECTED packet is received with bit 7='1', IBM SNA X.25 DTEs clear the call with appropriate Cause and Diagnostic codes (see Appendix H, "DTE-Generated Diagnostic Codes"). In any case, the error condition and Cause and Diagnostic codes must be reported to a higher layer.

2. SNA-to-non SNA Connections

   When 'D = 1' in a DATA packet having 'Ps=p', the significance of the returned Pr corresponding to that DATA packet (i.e., 'Pr $\geq$ p + 1') is an indication that a Pr has been received from the remote DTE for all data bits in the DATA packet which originally had 'D = 1'.

   Notes:

   a. To achieve a greater degree of reliability, DTEs may use the D-bit procedure to signify receipt of data by a higher layer entity. Such use requires prior agreement between the two DTEs. When using this procedure, the sending Packet Layer sets the D-bit of the last DATA packet in an M-bit sequence to 1 if end-to-end receipt confirmation by a higher layer entity is desired. On receiving the last DATA packet of an M-bit sequence with 'D = 1', the Packet Layer must not return the corresponding Pr until the data in this packet has been acknowledged by a higher layer entity. When this acknowledgement is received, the Packet Layer should return this Pr as soon as possible (e.g., without waiting for further DATA packets) to avoid the possibility of deadlocks. A DATA, RR, RNR, or REJECT (if subscribed to) packet may be used to convey the Pr (see note to § 4.4.1.6). Likewise, in a network environment, the DCE is required to send Pr to the DTE as soon as possible after the Pr is received from the remote DTE.

   b. If a Pr for a DATA packet with 'D = 1' is outstanding, local updating of the window will be deferred for subsequent DATA packets with 'D = 0'. Some networks may also defer updating the window for previous DATA packets (within the window) with 'D = 0' until the corresponding Pr for the packet with the outstanding 'D = 1' is transmitted to the DTE.

   c. Pr values corresponding to the data contained in DATA packets with the 'D=1' need not be the same at the DTE/DCE interfaces at each end of a virtual call or permanent virtual circuit.

d. If the DTE has sent DATA packets with 'D = 0', the DTE does not have to wait for local updating of the window by the DCE before initiating a resetting or clearing procedure.

e. When the DTE is unwilling to use the D-bit procedure and receives a DATA packet with 'D = 1', then it should reset the logical channel with a cause indicating "DTE-Originated" and the diagnostic "D-bit Procedure Not Supported."

If the virtual call has not been established indicating support of the D-bit procedure, IBM SNA X.25 DTEs do not send DATA packets with 'D = 1'. If they receive a packet with 'D = 1' from a non-SNA DTE they clear the virtual call or reset the permanent virtual circuit with appropriate Cause and Diagnostic codes (see Appendix H, "DTE-Generated Diagnostic Codes").

To be in compliance with ANS X3.100:

- The D-bit procedure shall be implemented by all networks.
- DTEs need not employ the D-bit procedures when transmitting to the network, but no DTE shall reject incoming packets with the D-bit set to '1' or '0' as having this bit in error, unless the receiving DTE knows the remote DTE has not implemented this value of the D-bit; in this case, the receiving DTE may treat such an occurrence as an error condition. Specifically, if this error condition applies and the packet received is acceptable to the state of the logical channel, then the DTE invokes the error procedure with diagnostic "D-bit Procedure Not Supported"

4.4.1.5 DTE and DCE RECEIVE_READY (RR) Packets

RR packets are used by the DTE or the DCE to indicate that it is ready to receive the 'W' DATA packets within the window starting with Pr, where Pr is indicated in the RR packet.

4.4.1.6 DTE and DCE RECEIVE_NOT_READY (RNR) Packets

RNR packets are used by the DTE or the DCE to indicate a temporary inability to accept additional DATA packets for a given virtual call or permanent virtual circuit. A DTE or DCE receiving an RNR packet shall stop transmitting DATA packets on the indicated logical channel, but the window is updated by the Pr value of the RNR packet. The receive not ready situation indicated by the transmission of an RNR packet is cleared by the transmission in the same direction of an RR or REJECT (if subscribed to) packet or by initiation of a resetting procedure.

The transmission of an RR packet after an RNR packet at the packet layer is not to be taken as a demand for retransmission of packets which have already been transmitted.

Note:

The RNR packet may be used to convey across the DTE/DCE interface the Pr value corresponding to the DATA packet which had 'D = 1' in the case that additional DATA packets cannot be accepted on SNA-to-non_SNA connections.

4.4.2 Throughput Characteristics and Classes

The definition of throughput and steady state throughput are given in § 4 of CCITT Recommendation X.135.

A throughput class for one direction of transmission is an inherent characteristic of the virtual call or permanent virtual circuit related to the amount of resources allocated to this virtual call or permanent virtual circuit. It is a measure of the steady state throughput that can be provided under optimal conditions on a virtual call or permanent virtual circuit. However, due to the statistical sharing of transmission and switching resources, it is not guaranteed that the throughput class can be reached 100% of the time.

The relationship between throughput class and the throughput parameters and objectives described in CCITT Recommendation X.135 require further study. The complete definition of the optimal conditions where the measure of the steady state throughput in relation to throughput class is meaningful also requires further study. Pending the results of these further studies, it cannot be guaranteed or verified that a network supporting a given throughput class value (64K bit/s for instance) offers better performance to its users than a network not supporting that throughput class. However, a network may offer a guarantee to its users on a contractual basis.

The optimal conditions per measurement include the following:

- Access line characteristics of the local and remote DTEs do not constrain the throughput class;

  Note:

  In particular, because of the overhead due to the frame and packet headers, when the throughput class corresponding to the user class of service of the DTE is applicable to a virtual call or permanent virtual circuit, a steady state throughput equal to that throughput class can never be reached.

- Window sizes at the local and remote DTE/DCE interfaces do not constrain the throughput;
- Traffic characteristics of other logical channels at local and remote DTE/DCE interfaces do not constrain the throughput;
- Receiving DTE is not flow controlling the DCE such that the throughput class is not attainable;
- Transmitting DTE sends only DATA packets which have the maximum data field length; and,
- 'D = 0'.

The throughput class is expressed in bits per second. The maximum User_Data field length is specified for a virtual call or permanent virtual circuit, and thus the throughput class can be interpreted by the DTE as the number of full DATA packets/second at the DTE/DCE interface.

In the absence of the Default_Throughput_Class_Assignment facility (see § 6.11), the default throughput classes for both directions of transmission correspond to the user class of service of the DTE (see § 7.2.2.2) but do not exceed the maximum throughput class supported by the network. Negotiation of throughput classes on a per call basis may be made with the Throughput_Class_Negotiation facility (see § 6.13).

Note:

> The sum of throughput classes of all virtual calls and permanent virtual circuits supported at a DTE/DCE interface may be greater than the data transmission rate of the access line.

4.4.3 Procedure for Reset

The reset procedures described in this section apply independently to each logical channel.

The reset procedure is used to re-initialize virtual call or permanent virtual circuit. When a Virtual Call or Permanent Virtual Circuit has just been reset, the following actions relative to the logical channel are taken.

- With respect to DATA packets:
  - those that have been transmitted are removed from the window,
  - those that have not been transmitted but are contained in an M-bit sequence for which some DATA packets were transmitted are flushed from the queue of DATA packets awaiting transmission, and
  - those that have been received but which do not constitute an entire M-bit sequence are flushed from the M-bit sequence reassembly area (as an alternative, these packets may be passed to a higher layer entity with an indication that they do not constitute an entire M-bit sequence).
- The lower window edge for each direction of data transmission is set to 0 and subsequently transmitted DATA packets are numbered starting from 0.
- Any receive-not-ready condition that had existed prior to the reset is considered not to exist any longer.
- All timer and retransmission parameters relating to data and interrupt transfer are set back to their initial value (these include T24, T25, T26, T27, R25, and R27).

In network applications, the reset procedure removes in each direction all DATA, INTERRUPT, and flow control packets that may be in the network associated with that logical channel.

The reset procedure can only apply in the Data_Transfer state (p4). In any other state, the reset procedure is abandoned. For example, when a clearing or restarting procedure is initiated, RESET_REQUEST and RESET_INDICATION packets can be left unconfirmed.

For flow control, there are three states d1, d2, and d3 within the Data_Transfer state (p4). They are Flow_Control_Ready (d1), DTE_Reset_Request (d2), and DCE_Reset_Indication (d3) as shown in the state diagram in Figure B-3. When entering state p4, the logical channel is placed in state d1. Table C-4 specifies actions taken by DCEs on receipt of packets from the DTE. Appendix I, "Description of DTE Packet Layer Actions" specifies actions taken by DTEs upon receipt of packets from DCEs.

4.4.3.1 Reset Request Packet

The DTE indicates a request for reset at any time by transmitting a RESET_REQUEST packet specifying the logical channel to be reset and by starting the Reset Request Response Timer (T22). This places the logical channel in the DTE_Reset_Request state (d2). DTEs discard DATA, [INTERRUPT,] RR, and RNR packets received on logical channels in the DTE_Reset_Request state. Packets of incomplete packet sequences, received in this state, are also discarded.

A diagnostic code as defined in Appendix H, "DTE-Generated Diagnostic Codes" must be included. Error conditions that cause a reset must be reported, with associated diagnostic codes, to a higher layer of SNA.

The failure to receive a RESET_CONFIRMATION packet before the expiration of T22 after transmission of a RESET_REQUEST packet is considered an error. The reset procedure is retried up to a maximum number of times R22. After this, for a Virtual Call logical channel, the Packet Layer clears the call with a cause indicating "DTE-Originated" and a diagnostic "Timer Expired Or Retransmission Count Surpassed For Reset Request." For a Permanent Virtual Circuit logical channel, the Packet Layer notifies the appropriate entity; the logical channel then remains in the DTE_Reset_Request state (d2).

4.4.3.2 Reset Indication Packet

The DCE will indicate a reset by transmitting to the DTE a RESET_INDICATION packet, specifying the logical channel being reset and the reason for the resetting. This places the specified logical channel in the DCE_Reset_Indication state (d3). In this state, the DCE will ignore DATA, [INTERRUPT,] DTE_RNR and DTE_RR packets. In this state, the DTE considers subsequent receipt of any DATA, INTERRUPT, RECEIVE_READY, or RECEIVE_NOT_READY packets as an error. It discards any such packet and transmits a RESET_REQUEST packet with a cause indicating "DTE-Originated" and the diagnostic "Packet Type Invalid for State d3". DTEs discard untransmitted packets of send packet sequences and notify a higher layer of the inoperative condition, reporting the resetting cause and diagnostic codes.

In a DTE/DTE environment, the RESET_INDICATION packet received by one DTE is the same as the RESET_REQUEST packet transmitted by the other DTE.

In a DTE/DCE environment, RESET_INDICATION packets are used as a normal sequence for packet layer initialization, e.g.:

- A RESET_INDICATION packet with Cause "Out-of-Order (x'01')" is returned by the X.25-based network to indicate that the remote DTE/DCE interface has not, as yet, been initialized.

- A RESET_INDICATION packet with Cause, "DTE-Originated (x'00')" and the Diagnostic, "PU_Not_Available" #197 (x'C6') is returned by an SNA NIA to indicate that the SNA SDLC link has not, as yet, been initialized.
- RESET_INDICATION packets with Cause, "Remote DTE Operational" (x'09')" are propagated by X.25-based networks for each permanent virtual circuit as a result of a restarting procedure at the remote DTE/DCE interface.
- A RESET_INDICATION packet with cause "Network Congestion" will be received from the DCE if a momentary failure occurs within the network.
- A RESET_INDICATION packet with cause "Network Out of Order" will be received from the DCE if a network has a temporary inability to handle data traffic.
- In the previous situation, a RESET_INDICATION Packet with cause "Network Operational" will be received from the DCE on a Permanent Virtual Circuit when the network can handle data traffic again.

After processing the RESET_INDICATION packet, the DTE transmits a RESET_CONFIRMATION packet across the interface.

4.4.3.3 Reset Collision

Reset collision occurs when a DTE and a DCE simultaneously transmit a RESET_REQUEST packet and a RESET_INDICATION packet specifying the same logical channel. In this event the DCE and the DTE will consider that the reset is complete. The DCE will not expect a DTE_RESET_CONFIRMATION packet and will not transfer a DCE_RESET_CONFIRMATION packet. DTEs do not expect a DCE_RESET_CONFIRMATION packet and do not transfer a DTE_RESET_CONFIRMATION packet when a reset collision occurs. This places the specified logical channel in the Flow_Control_Ready state (d1).

4.4.3.4 Reset Confirmation Packets

When a logical channel is in the DTE_Reset_Request state (d2), the DCE will confirm the reset by transmitting a DCE_RESET_CONFIRMATION packet.

In a network environment, the DCE_RESET_CONFIRMATION packet can only be interpreted universally as having local significance; however, within some Administrations' networks, reset confirmation may have end-to-end significance. In all cases the time spent in the DTE_Reset_Request state (d2) will not exceed time-limit T22 (see Appendix D, "DCE Time-outs and DTE Time-limits" on page D-1).

When the logical channel is in the DCE_Reset_Indication state (d3), the DTE will confirm the reset by transmitting a DTE_RESET_CONFIRMATION packet before time T12 elapses. This places the logical channel in the Flow_Control_Ready state (d1). The action taken by the DCE when the DTE does not confirm the reset within time-out T12 are given in Appendix D, "DCE Time-outs and DTE Time-limits" on page D-1.

4.5 Effects of Clear, Reset and Restart Procedures on the Transfer of Packets

All DATA [and INTERRUPT] packets generated by a DTE (or the network) before initiation by the DCE or the DTE of a clear, reset or restart procedure at the local interface will either:

- be delivered to the remote DTE before the DCE transmits the corresponding indication on the remote interface, or
- be discarded by the network.

No DATA [or INTERRUPT] packets generated by a DTE (or the network) after completion of a reset (or for permanent virtual circuits also a restart) procedure at the local interface will be delivered to the remote DTE before completion of the corresponding reset procedure at the remote interface.

When a DTE initiates a clear, reset or restart procedure on its local interface, all DATA and [INTERRUPT] packets which were generated by the remote DTE (or the network) before the corresponding indication is transmitted to the remote DTE will either:

- be delivered to the initiating DTE before DCE confirmation of the initial clear, reset or restart request, or
- be discarded by the network.

Note:

The maximum number of packets that may be discarded, by the network as a result of a clear, reset or restarting procedure, is a function of:

- network end-to-end delay and
- throughput characteristics

and, in general, has no relation to the local window size.

4.5.1 SNA-to-non_SNA Connections

[For virtual calls and permanent virtual circuits on which all DATA packets are transferred with 'D=1', the maximum number of packets that may be discarded in one direction of transmission is never larger than the window size for the direction of transmission].

4.6 Effects of the Physical and Data Link Layer on the Packet Layer

4.6.1 General principles

In general, if a problem detected in a layer (physical, data link or packet layer) can be resolved in this layer according to the DCE error recovery procedures provided in this specification without loss or duplication of data, the adjacent layers are not involved in recovery.

If error recovery by the DCE implies a possible loss or duplication of data, the higher layer is informed.

Reinitialization of a layer by the DCE is only performed if a problem cannot be resolved in that layer.

Changes of operational states of the physical layer and the data link layer of the interface do not implicitly change the state of each logical channel at the packet layer. Such changes when they occur are explicitly indicated at the packet layer by use of restart, clear or reset procedures as appropriate.

4.6.2 Definition of an out-of-order condition

In the case of a single link procedure, there is an out-of-order condition when:

- a failure on the physical and/or data link layer is detected: a failure being defined as a condition in which the DCE cannot transmit or cannot receive any frame because of abnormal conditions caused by, for instance, a line fault between DTE and DCE;

  Note:

  Short physical layer outages (e.g., loss of carrier) are not considered as physical layer failures by the DCE and the data link and packet layers are not informed.

- the DCE has received or transmitted a DISC command.

There may be other network-dependent out-of-order conditions such as:

- reset of the data link layer,
- expiration of T3 timer (see § 2.4.5.3),
- receipt or transmission of a DM response,
- etc.

In the case of the Multilink procedure, an out-of-order condition is considered as having occurred when it is present at the same time for every single link procedure of the DTE/DCE interface. There may be other network-dependent out-of-order conditions such as the performance by DTE or DCE of the multilink resetting procedure (see § 2.5.4.2), loss of multilink frame(s) (see § 2.5.4.4), etc.

4.6.3 Packet Layer Actions on Out-Of-Order Conditions

When an out-of-order condition is detected, the DCE will transmit to the remote end:

1. a reset with the cause "Out-of-Order" for each permanent virtual circuit; and,
2. a clear with the cause "Out-of-Order" for each existing virtual call.

4.6.4 Packet Layer Actions during Out-Of-Order Conditions

During an out-of-order condition:

- the DCE will clear any incoming virtual call with the cause "Out-of-Order";
- for any data or interrupt packet received from the remote DTE on a permanent virtual circuit, the DCE will reset the permanent virtual circuit with the cause "Out-of-Order";
- a reset packet received from the remote DTE on a permanent virtual circuit will be confirmed to the remote DTE by either reset confirmation or reset indication packet.

When an out-of-order condition is recovered:

- The DCE will send a restart indication packet with the cause "Network operational" to the local DTE;
- a reset with the cause "Remote_DTE_Operational" will be transmitted to the remote end of each permanent virtual circuit.

IBM SNA X.25 DTEs report all "Out-of-Order" cause and diagnostic codes to a higher layer.

Chapter 5. Packet Formats

5.1 General

A packet always consists of at least three octets. These three octets contain the General Format Identifier Field, the Logical Channel Identifier Field, and the Packet Type Identifier Field. Depending on the particular packet type, other fields may also be defined.

The possible extension of X.25 packet formats by the addition of new fields is being considered by the CCITT.

Note:

Any such field:

- would only be provided as an addition following all previously defined fields, and not as an insertion between any of the previously defined fields;
- would be transmitted to a DTE only when either the DCE has been informed that the DTE is able to interpret this field and act upon it, or when the DTE can ignore the field without adversely affecting the operation of the DTE/DCE interface (including charging); and,
- would not contain any information pertaining to a user facility to which the DTE has not subscribed, unless the DTE can ignore the facility without adversely affecting the operation of the DTE/DCE interface (including charging).

Note:

This warning suggests that, in the interest of efficiency and upward compatibility with future versions of X.25, care should be taken not to reject received packets whose length would exceed what is usually expected for a given packet type; and, that interpretation of the packet should proceed so as to act on previously defined fields and ignore newly defined fields. However, such a position has not been embraced in the standards arena where, emerging conformance tests require that receipt of packets exceeding the maximum length be treated as format errors. Prudence, therefore, suggests that products in development include length checks where appropriate.

Bits of an octet are numbered 8 to 1 where bit 1 is the low order bit and is transmitted first. Octets of a packet are consecutively numbered starting from '1' and are transmitted in this order.

5.1.1 General Format Identifier

The General Format Identifier (GFI) field is a four bit binary coded field which is provided to indicate the general format of the rest of the header. The General Format Identifier field is located in bit positions 8, 7, 6 and 5 of octet 1, and bit 5 is the low order bit (see Table 16). See also "Relationship to ISO_Open System Interconnection (OSI)" on page 9-5.

Bit 8 of the General Format Identifier is the Qualifier 'Q' bit in DATA packets, the Address bit in call set-up and clearing packets, and is set to '0' in all other packets.

Bit 7 of the General Format Identifier is used for the delivery confirmation procedure in DATA and Call Set-up packets and is set to '0' in all other packets. It must be '0' in all packets on SNA-to-SNA connections.

Bits 6 and 5 are encoded for four possible indications. Two of the codes are used to distinguish packets using modulo '8' packet sequence numbering from packets using modulo '128' packet sequence numbering. The third code is used to indicate an extension to an expanded format for a family of General Format Identifier codes which are being considered by the CCITT. The fourth code is reserved for other applications (see Figure 9-2 on page 9-7).

Notes:

1. The DTE must encode the GFI to be consistent with whether or not it has subscribed to the Extended Packet Numbering facility (see § 6.2).
2. It is envisaged that other general format identifier codes could identify alternative packet formats.
3. Other GFI values (i.e., x'0, 4, 7, 8, B, C and F') are considered invalid and ignored by IBM SNA X.25 DTEs which take no action except to inform a higher layer of their receipt.

Table 16: General Format Identifier

General format identifier		Octet 1 bits 8 7 6 5
Call Set-Up Packets	Sequence Numbering Scheme Modulo 8	X X 0 1
	Sequence Numbering Scheme Modulo 128	X X 1 0
Clearing Packets	Sequence Numbering Scheme Modulo 8	X 0 0 1
	Sequence Numbering Scheme Modulo 128	X 0 1 0
Flow Control, Interrupt, Reset, Restart, Registration and Diagnostic packets	Sequence Numbering Scheme Modulo 8	0 0 0 1
	Sequence Numbering Scheme Modulo 128	0 0 1 0
DATA packets	Sequence Numbering Scheme Modulo 8	X X 0 1
	Sequence Numbering Scheme Modulo 128	X X 1 0
General Format Identifier extension		0 0 1 1
Reserved for other applications		* * 0 0

* Undefined
Note: A bit which is indicated as "X" may be set to either '0' or '1' as indicated in the text.

5.1.2 Logical Channel Group Number

The Logical Channel Group Number appears in every packet except RESTART, DIAGNOSTIC and REGISTRATION packets in bit positions 4, 3, 2 and 1 of octet 1. For each logical channel, this number has local significance at the DTE/DCE interface.

This field is binary coded and bit 1 is the low order bit of the Logical Channel Group Number. In RESTART, DIAGNOSTIC and REGISTRATION packets, this field is coded x'0'.

5.1.3 Logical Channel Number

The Logical Channel Number appears in every packet except RESTART, DIAGNOSTIC and REGISTRATION packets in all bit positions of octet 2. For each logical channel, this number has local significance at the DTE/DCE interface.

This field is binary coded and bit 1 is the low order bit of the Logical Channel Number. In RESTART, DIAGNOSTIC and REGISTRATION packets, this field is coded x'00'.

5.1.4 Packet Type Identifier

Each packet is identified in octet 3 according to Table 17.

Table 17: Packet Type Identifier

PACKET TYPE		OCTET 3 BITS
From DCE to DTE	From DTE to DCE	8 7 6 5 4 3 2 1
Call Set-up and Clearing		
INCOMING_CALL - (INC)	CALL_REQUEST - (CRQ)	0 0 0 0 1 0 1 1
CALL_CONNECTED - (CCN)	CALL_ACCEPTED - (CAC)	0 0 0 0 1 1 1 1
CLEAR_INDICATION - (CLI)	CLEAR_REQUEST - (CLR)	0 0 0 1 0 0 1 1
DCE_CLEAR_CONFIRMATION - NCC)	DTE_CLEAR_CONFIRMATION - (TCC)	0 0 0 1 0 1 1 1
Data and [Interrupt]		
DCE_DATA - (NDT)	DTE_DATA - (TDT)	X X X X X X X 0
[DCE_INTERRUPT] - (NIN)	[DTE_INTERRUPT] - TIN)	0 0 1 0 0 0 1 1
[DCE_INTERRUPT_ CONFIRMATION] - (NIC)	[DTE_INTERRUPT_ CONFIRMATION] - (TIC)	0 0 1 0 0 1 1 1
Flow Control and Reset		
DCE_RR_(MODULO 8) - (NRR)	DTE_RR_(MODULO 8) - (TRR)	X X X 0 0 0 0 1
DCE_RR_(MODULO 128)* - (NRR)	DTE_RR_(MODULO 128)* - (TRR)	0 0 0 0 0 0 0 1
DCE_RNR_(MODULO 8) - (NNR)	DTE_RNR_(MODULO 8) - (TNR)	X X X 0 0 1 0 1
DCE_RNR_(MODULO 128)* - (NNR)	DTE_RNR_(MODULO 128)* - (TNR)	0 0 0 0 0 1 0 1
	DTE_REJ_(MODULO 8)* - (TRJ)	X X X 0 1 0 0 1
	DTE_REJ_(MODULO 128)* - (TRJ)	0 0 0 0 1 0 0 1
RESET_INDICATION - (RSI)	RESET_REQUEST - (RSR)	0 0 0 1 1 0 1 1
DCE_RESET_CONFIRMATION - (NRC)	DTE_RESET_CONFIRMATION - (TRC)	0 0 0 1 1 1 1 1
Restart		
RESTART_INDICATION - (IRI)	RESTART_REQUEST - (IRR)	1 1 1 1 1 0 1 1
DCE_RESTART_CONFIRMATION - (NSC)	DTE_RESTART_CONFIRMATION - (TSC)	1 1 1 1 1 1 1 1
Diagnostic		
DIAGNOSTIC* - (DGN)		1 1 1 1 0 0 0 1
Registration*		
	REGISTRATION_REQUEST - (RRQ)	1 1 1 1 0 0 1 1
REGISTRATION_CONFIRMATION - (RCN)		1 1 1 1 0 1 1 1

* = Not necessarily available on every network.
Note: A bit which is indicated as "X" may be set to either '0' or '1' as indicated in the text.

Notes on Table 17::

1. Modulo 128 numbering is used only with the Extended Packet Sequence as Numbering Facility.
2. A DTE may transmit a REJECT packet only if the optional Packet Retransmission Facility has been subscribed to for transmission of REJECT packets.

3. A DCE will never transmit a REJECT packet and, therefore, a DTE need not be able to process a received REJECT packet in a DTE/DCE environment. On the other hand, a DTE must be able to process a received REJECT packet in a DTE/DTE environment only if the agreement to use the optional Packet Retransmission Facility includes retransmission of DATA packets by the DTE.

4. A DTE may transmit a DIAGNOSTIC packet only in a DTE/DTE environment and only if it can be set to suppress its generation when connected to a network.

5. In a DTE/DCE environment, a DTE may receive a DIAGNOSTIC packet from a DCE if implemented by the network. In a DTE/DTE environment, a DTE may receive a DIAGNOSTIC packet from a DTE only if the transmitting DTE can be set to suppress its generation when connected to a network.

6. Registration packets are used only if the optional On-line Facility Registration Facility has been subscribed to.

7. A DCE will never transmit a REGISTRATION REQUEST packet and, therefore, a DTE need not be able to process a received REGISTRATION REQUEST packet in a DTE/DCE environment. On the other hand, a DTE must be able to process a received REGISTRATION REQUEST packet in a DTE/DTE environment only if the agreement to use the optional On-line Facility Registration Facility includes the DTE responding to registration-procedure initiation.

8. A DTE may not transmit a REGISTRATION CONFIRMATION packet in a DTE/DCE environment. On the other hand, a DTE must be able to transmit a REGISTRATION CONFIRMATION packet in response to a REGISTRATION REQUEST packet only if the agreement to use the optional On-line Facility Registration Facility includes the DTE responding to registration-procedure initiation.

5.2 Call Set-Up and Clearing Packets

5.2.1 Address Block Format

The call set-up and clearing packets contain an address block. This address block has two possible formats: a non TOA/NPI (Type of Address/Numbering Plan Identifier) address format and a TOA/NPI address format. These two formats are distinguished by bit 8 of the general format identifier (A bit). When the A bit is set to 0, the non TOA/NPI address format is used. When the A bit is set to 1, the TOA/NPI address format is used.

The non TOA/NPI address format is supported by all networks. The TOA/NPI address format may be supported by some networks, in particular by those networks wishing to communicate with ISDNs for which the non TOA/NPI address format provides insufficient addressing capability.

Note:

Prior to 1997, packet-mode DTEs operating according to case B of CCITT Recommendation X.31 (ISDN virtual circuit bearer service) will be addressed by a maximum 12 digit address from the E.164

numbering plan. After 1996, such packet-mode DTEs may have 15 digit E.164 address; TOA/NPI address procedures will be required to address the DTEs. CCITT Recommendations E.165 and E.166 provide further guidance.

When transmitting a call set-up or clearing packet, a DCE will use the TOA/NPI address format if the DTE has subscribed to the TOA/NPI address subscription facility (see § 6.26), the non TOA/NPI address format if it has not.

Note:

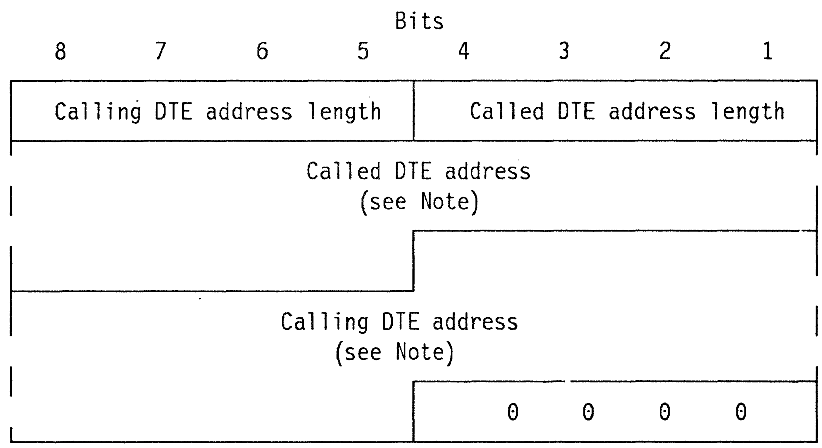
This facility is designated in CCITT Recommendation X.32 as "for further study."

When transmitting a call setup or clearing packet, a DTE will use the TOA/NPI address format if it has subscribed to the TOA/NPI address subscription facility, the non TOA/NPI address format if it has not.

When the address format useo by one DTE in a call set-up or clearing packet is different from the address format used by the remote DTE, the network (if it supports the TOA/NPI address format) converts from one address format to the other (see § 6.28).

5.2.1.1 Format of the address block when the A bit is set to 0

Figure 4 illustrates the format of the address block when the A bit is set to 0.



Note: The figure is drawn assuming the number of address digits present in the called DTE address is odd and the number of address digits present in the calling DTE address field is even.

Figure 5-1. Format of the address block when the A bit is set to 0

Called and calling DTE address length fields: These fields are four bits long each and consist of field length indicators for the called and calling DTE addresses. Bits 4, 3, 2 and 1 indicate the length of the called DTE address in semi-octets. Bits 8, 7, 6 and 5 indicate the length of the calling DTE address in semi-octets. Each DTE address length indicator is binary coded and bit 1 or bit 5 is the low order bit of the indicator.

Called and calling DTE address fields: Each digit of an address is coded in a semi-octet in binary coded decimal with bit 5 or bit 1 being the low-order bit of the digit.

Starting from the high order digit, the address is coded in octet 5 and consecutive octets with two digits per octet. In each octet, the higher order digit is coded in bits 8, 7, 6 and 5.

When present, the calling DTE address field starts on the first semi- octet following the end of the called DTE address field. Consequently, when the number of digits of the called DTE address field is odd, the beginning of the calling DTE address field, when present, is not octet aligned.

When the total number of digits in the called and calling DTE address fields is odd, a semi-octet with zeros in bits 4, 3, 2 and 1 will be inserted after the calling DTE address field in order to maintain octet alignment.

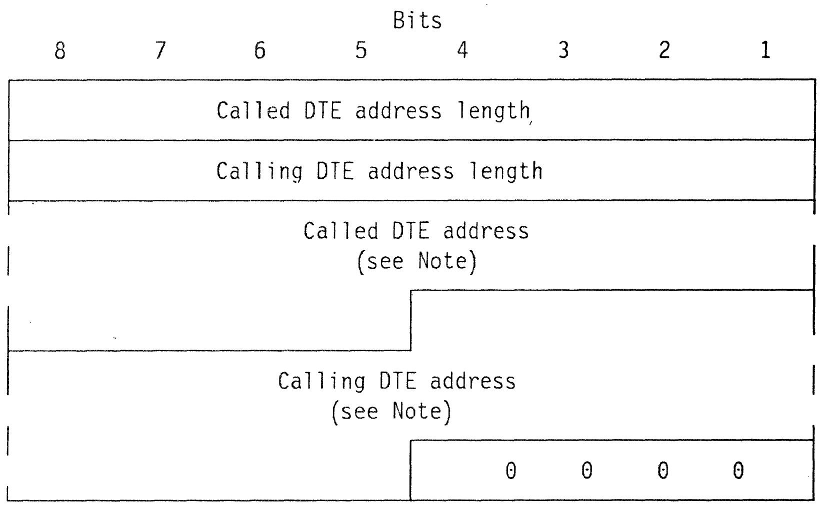
Further information on the coding of called and calling DTE address fields is given in Appendix V, "Addresses in Call Set-up and Clearing Packets."

Note:

These fields may be used for optional addressing facilities such as abbreviated addressing. The optional addressing facilities employed as well as coding of those facilities are being considered by the CCITT.

5.2.1.2 Format of the address block when the A bit is set to 1

Figure 5 illustrates the format of the address block when the A bit is set to 1.



Note: The figure is drawn assuming the number of semi-octets present in the called DTE address is odd and the number of semi-octets present in the calling DTE address field is even.

Figure 5-2. Format of the address block when the A bit is set to 1

Called and calling DTE address length fields: These fields are one octet long each and consist of field length indicators for the called and calling DTE addresses. They indicate the length of the called DTE address and the calling DTE address, respectively in semi-octets. Each DTE address length indicator is binary coded and bit 1 is the low order bit of the indicator.

The maximum value of a DTE address length indicator is 17.

Called and calling DTE address fields: These fields respectively consist of the called DTE address when present, and the calling DTE address when present. Each DTE address when present, has these sub-fields:

- type of address subfield (TOA),
- numbering plan identification subfield (NPI),
- address digits subfield.

The first two subfields are at the beginning of the address and are binary coded with the values indicated in Figures 5-3 and 5-4.

Note:

Currently, no non-BCD encodable values have been allocated for type of address and numbering plan identification subfields.

A DTE address containing type of address and numbering plan identification subfields but no address digits subfield is invalid.

Bits: 8 7 6 5 or Bits: 4 3 2 1 (see note 1)	Type of address
0 0 0 0	Network dependent number (see note 2)
0 0 0 1	International number (see note 3)
0 0 1 0	National number (see note 3)
to be defined	Complementary address alone (note 4)
other values	Reserved

Notes:

1. The type of address subfield of the called DTE address field uses bits 8, 7, 6 and 5. The type of address subfield of the calling DTE address field uses bits 4, 3, 2 and 1 if the called DTE address field does not end on an octet boundary, otherwise, it uses bits 8, 7, 6 and 5.
2. In this case, the address digits subfield present after the type of address and numbering plan identification subfields is organized according to the network numbering plan, e.g., prefix or escape code might be present. This case is equivalent to the use of the same code point in Q.931 where it is called "unknown".
3. As per Q.931, prefix or escape codes shall not be included in the address digits subfield.
4. For the definition of a complementary address, see Appendix V, "Addresses in Call Set-up and Clearing Packets."

Figure 5-3. Coding of the type of address subfield

Bits: 8 7 6 5 or Bits: 4 3 2 1 (see note 1)	Numbering plan
0 0 0 1 to be defined other values	X.121 (see Note 2) Network-dependent (see Note 3) Reserved (see Note 4)

Notes:

1. The numbering plan identification subfield of the called DTE address field uses bits 4, 3, 2 and 1. The numbering plan identification subfield of the calling DTE address field uses bits 8, 7, 6 and 5 if the called DTE address does not end on an octet boundary, otherwise it uses bits 4, 3, 2 and 1.
2. A mechanism equivalent to that provided by escape digits as defined in CCITT Recommendation X.121, is not yet defined for use in conjunction with the TOP/NPI capability. Such a mechanism will not use the numbering plan identification subfield. Until the availability of such a mechanism (potentially, an optional user facility), only the code point for X.121 shall be used. The X.121 escape codes shall apply and, when they are used, the type of address subfield shall indicate network dependent numbers.
3. In this case, the address digits subfield present after the type of address and numbering plan identification subfields is organized according to the network numbering plan, e.g., prefix or escape code might be present.
4. Included among the reserved values are those corresponding to numbering plan identifiers in Q.931 (e.g., F.69, E.164).organized

Figure 5-4. Coding of the numbering plan subfield

The other semi-octets of a DTE address are digits, coded in binary coded decimal with bit 5 or 1 being the low order bit of the digit. Starting from the high order digit, the address digits are coded in consecutive semi-octets. In each octet, the higher order digit is coded in bits 8, 7, 6 and 5.

When present, the calling DTE address field starts on the first semi- octet following the end of the called DTE address field. Consequently, when the number of semi-octets of the called DTE address field is odd, the beginning of the calling DTE address field, when present, is not octet aligned.

When the total number of semi-octets in the called and calling DTE address fields is odd, a semi-octet with zeros in bits 4, 3, 2 and 1 will be inserted after the calling DTE address field in order to maintain octet alignment.

Further information on the coding of called and calling DTE address fields is given in Appendix V, "Addresses in Call Set-up and Clearing Packets."

Note:

These fields may be used for optional addressing facilities such as abbreviated addressing. The optional addressing facilities employed as well as the coding of these facilities are for further study.

5.2.2 CALL_REQUEST and INCOMING_CALL Packets

Figure 5-5 illustrates the format of CALL_REQUEST and INCOMING_CALL packets.

In a DTE/DCE environment, the CALL_REQUEST packet and INCOMING_CALL packet are two different "physical" packets because of the intervening network. However, in a DTE/DTE environment, the CALL_REQUEST packet sent by one DTE is the same as the INCOMING_CALL packet received by the other DTE.

Octet	Bits 8	7	6	5	4	3	2	1
1	General Format Identifier (GFI) (see Note)				Logical Channel Group Number			
2	Logical Channel Number							
3	Packet Type Identifier							
	0	0	0	0	1	0	1	1
4 . .	Address Block (see § 5.2.1)							
.	Facility Length							
.	Facilities							
. . n	Call User Data (see Note 2)							

Notes: 1. GFI – Coded XY01 (modulo 8) or XX10 (modulo 128).
Where: 'Y = 0' on SNA-to-SNA Connections.
'Y = 0 or 1' on SNA-to-non SNA Connections.
2. The first octet of the Call_User_Data field is required and bits 8 and 7 have particular significance (see Protocol Identifier (PI)).

Figure 5-5. CALL_REQUEST and INCOMING_CALL Packet Format

5.2.2.1 General Format Identifier

Bit 8 of octet 1 (A bit) should be set as described in § 5.2.1. On SNA-to-non SNA connections, bit 7 of octet 1 is set to '0' unless the 'D' bit mechanism defined in § 4.3.3 is used. CALL_REQUEST and INCOMING_CALL packets must have bit 7 of octet 1 set to '0' on SNA-to-SNA connections.

5.2.2.2 Address block

The address block is described in § 5.2.1.

5.2.2.3 Facility Length Field

The octet following the Address field indicates the length of the Facility field in octets. The facility length indicator is binary coded and bit 1 is the low order bit of the indicator.

5.2.2.4 Facility Field

The Facility field is present only when the DTE is using an optional user facility requiring some indication in CALL_REQUEST and INCOMING_CALL packets.

The coding of the Facility field is defined in §§ 6.0 and 7.0.

The Facility field contains an integral number of octets. The actual maximum length of this field depends on the facilities that are offered by the network. However, this maximum does not exceed 109 octets.

Note:

It is for further study whether another value should be defined, relative to the total number of octets in a packet.

5.2.2.5 Call_User_Data Field

Following the facility field, the Call_User_Data field may be present and has a maximum length of 128 octets when used in conjunction with the Fast_Select facility described in § 6.16, 16 octets in the other case.

<u>Protocol Identifier (PI)</u>

This section applies to IBM SNA DTEs only. See § 9.4.1.

The first octet of the Call_User_Data field is the Protocol Identifier (PI) which is mandatory in SNA environments.

The use and format of the Call_User_Data field is determined by the setting of bits 8 and 7 of the first octet of this (Protocol Identifier) field. If bits 8 and 7 of the first octet of the Call_User_Data field are:

'11' the Call_User_Data belongs to a higher layer.

Receipt of an incorrect setting of bits 8 or 7 (other than '11'), by IBM SNA X.25 DTEs results in call clearing with the diagnostic code x'EB', "Invalid Protocol Identifier."

Bit 2 of the Protocol Identifier also has particular significance in SNA environments:

'0' - for SNA-to-non SNA connections; or,

'1' - for SNA-to-SNA connections.

Note:

Some networks require the Call_User_Data field to contain an integral number of octets (see § 3, Note 1).

When a virtual call is being established between two packet mode DTEs, the network does not act on any part of the Call_User_Data field. In other circumstances, see CCITT Recommendation X.244.

5.2.3 CALL_ACCEPTED and CALL_CONNECTED Packets

Figure 5-6 illustrates the format of CALL_ACCEPTED and CALL_CONNECTED packets in the basic and extended format.

In a DTE/DCE environment, the CALL_ACCEPTED packet and CALL_CONNECTED packet are two different "physical" packets because of the intervening network. However, in a DTE/DTE environment, the CALL_ACCEPTED packet sent by one DTE is the same as the CALL_CONNECTED packet received by the other DTE.

Octet	Bits 8	7	6	5	4	3	2	1	
1	General format identifier (GFI) (see Note)				Logical channel group number				
2	Logical channel number								
3	Packet type identifier								
	0	0	0	0	1	1	1	1	
4 . . .	Address block (see Chapter 5.2.1)								a)
.	Facility length								a)
.	Facilities								a)
. . n	Call_User_Data								b)

a) These fields are not mandatory in CALL_ACCEPTED packets (see § 5.2.2.1).
b) This field may be present only in the extended format (see § 5.2.2.2).

Note:

GFI - Coded XY01 (modulo 8) or 0X10 (modulo 128).
Where Y = '0' on SNA-to-SNA connections; and,
Y = '0' or '1' on SNA-to-non SNA connections.

Figure 5-6. CALL_ACCEPTED and CALL_CONNECTED Packet Format

5.2.3.1 Basic Format

- General Format Identifier

  Bit 8 of octet 1 (A bit) should be set as described in § 5.2.1.

  On SNA-to-non_SNA connections, bit 7 of octet 1 is equal to '0' unless the 'D' bit mechanism defined in § 4.3.3 is used.

  CALL_ACCEPTED and CALL_CONNECTED packets must have bit 7 of octet 1 set to '0' on SNA-to-SNA connections.

- Address block

  The address block is described in § 5.2.1.

  Address Length Fields are required in CALL_ACCEPTED packets, even if they are set to zero.

- Facility Length Field

  The octet following the Address Block indicates the length of the facility field in octets. The facility length indicator is binary coded and bit 1 is the low order bit of the indicator.

  The Facility Length Field is required in CALL_ACCEPTED packets, even if it is set to zero.

- Facility Field

  The facility field is present only when the DTE is using an optional user facility requiring some indication in the CALL_ACCEPTED and CALL_CONNECTED packets.

  The coding of the facility field is defined in §§ 6.0 and 7.0.

  The facility field contains an integral number of octets. The actual maximum length of this field depends on the facilities which are offered by the network. However, this maximum does not exceed 109 octets.

  Note:

  It is for further study whether another value should be defined, relative to the total number of octets in the packet.

5.2.3.2 Extended Format

The extended format may be used only in conjunction with the Fast_Select facility described in § 6.16. In this case, the Called_User_Data field may be present and has a maximum length of 128 octets.

To be in compliance with ISO 8208, the address length and facility length fields must be present, even if they are set to zero.

Note:

Some networks require the Called_User_Data field to contain an integral number of octets (see § 3, Note 1). To be in compliance with ISO 8208, this field must contain an integral number of octets.

When the virtual call is being established between two packet-mode DTEs, the network does not act on any part of the Called_User_Data field. See CCITT Recommendation X.244.

5.2.4 CLEAR_REQUEST and CLEAR_INDICATION Packets

Figure 5-7 illustrates the format of CLEAR_REQUEST and CLEAR_INDICATION packets

In a DTE/DCE environment, the CLEAR_REQUEST packet and CLEAR_INDICATION packet are two different "physical" packets because of the intervening network. However, in a DTE/DTE environment, the CLEAR_REQUEST packet sent by one DTE is the same as the CLEAR_INDICATION received by the other DTE. in basic and extended formats.

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier (GFI)				Logical channel group number			
2	Logical channel number							
3	Packet type identifier							
	0	0	0	1	0	0	1	1
4	Clearing cause							
5	Diagnostic code (This field is mandatory on SNA-to-SNA Connections (see Note)							
.	Address Block (see Chapter 5.2.1) b)							
.	Facility length b)							
.	Facilities b)							
. . n	Clear_User_Data b)							

b) These fields may be present only in the extended format (see § 5.2.4.2).

GFI - Coded X001 (modulo 8) or X010 (modulo 128).

Note: Appendix H, "DTE-Generated Diagnostic Codes"

Figure 5-7. CLEAR_REQUEST and CLEAR_INDICATION Packet Format

5.2.4.1 Basic Format

- Clearing Cause Field

  Octet 4 is the clearing cause field and contains the reason for the clearing of the call.

  In CLEAR_REQUEST packets, the clearing cause field should be set by the DTE to one of the following values which indicate "DTE Originated":

```
  bits:  8  7  6  5  4  3  2  1
 value:  0  0  0  0  0  0  0  0
    or:  1  x  x  x  x  x  x  x  where each 'x' may be
                                  independently set to '0'
                                  or '1' by the DTE.
```

  To be in compliance with ISO 8208, each 'x' must be set to '0' by the DTE. Other values for X are for use by Private Packet Switched Data Networks (which appear as DTEs to the public network).

  The DCE will prevent values of the clearing cause field other than those shown above from reaching the other end of the call by either accepting the CLEAR_REQUEST packet and forcing the clearing cause field to all zeros in the corresponding CLEAR_INDICATION packet, or considering the CLEAR_REQUEST as an error and following the procedure described in Appendix C, "Packet Layer DCE Actions."

  In a DTE/DCE environment, a DTE must be able to accept any value in the Clearing Cause Field in a CLEAR_INDICATION packet. In a DTE/DTE environment, a DTE may either handle a clearing cause other than "DTE Originated" as it does in DTE/DCE environment (i.e., process the packet normally) or treat it as an error. In the latter case, the Packet Layer transmits a CLEAR_REQUEST packet with a cause indicating "DTE Originated" and the diagnostic "Improper Cause Code From DTE."

  The coding of the clearing cause field in CLEAR_INDICATION packets is given in Table 18.

Table 18: Coding of the Clearing Cause Field in CLEAR_INDICATION packets — Bits	8 7 6 5 4 3 2 1
DTE Originated	0 0 0 0 0 0 0 0
DTE Originated–	1 0 0 0 0 0 0 0
Number busy	X 0 0 0 0 0 0 1
Out of order	X 0 0 0 1 0 0 1
Remote procedure error	X 0 0 1 0 0 0 1
Reverse charging acceptance not subscribed	X 0 0 1 1 0 0 1
Incompatible destination	X 0 1 0 0 0 0 1
Fast select acceptance not subscribed	X 0 1 0 1 0 0 1
Ship absent.	X 0 1 1 1 0 0 1
Invalid facility request	X 0 0 0 0 0 1 1
Access barred	X 0 0 0 1 0 1 1
Local procedure error	X 0 0 1 0 0 1 1
Network congestion	X 0 0 0 0 1 0 1
Not obtainable	X 0 0 0 1 1 0 1
RPOA out of order	X 0 0 1 0 1 0 1
Gateway–detected Procedure Error	1 1 0 0 0 0 0 1
Gateway Congestion	1 1 0 0 0 0 1 1

– May be received only if the corresponding optional user user facility is used.
– Used in conjunction with mobile maritime service.
The bit indicated as "X" set to 0 indicates a resetting cause generated by a public data network and set to 1 indicates a resetting cause generated by a private network.

- Diagnostic Code

  Octet 5 is the Diagnostic_Code and provides additional information on the reason for the clearing of the call.

  In a CLEAR_REQUEST packet, the Diagnostic Code Field is required, even if it indicates no additional information.

  Diagnostic Codes generated by IBM SNA X.25 DTEs for CLEAR_REQUEST packets on SNA-to-SNA and SNA-to-non-SNA connections are specified in Appendix H, "DTE-Generated Diagnostic Codes."

  In a CLEAR_INDICATION packet, if the Clearing_Cause field indicates "DTE_Originated," the Diagnostic_Code is passed unchanged from the clearing DTE. If the clearing DTE has not provided a Diagnostic_Code in its CLEAR_REQUEST packet, then the bits of the Diagnostic_Code in the resulting CLEAR_INDICATION packet will be x'00'.

When a CLEAR_INDICATION packet results from a RESTART_REQUEST packet, the value of the Diagnostic_Code will be that specified in the RESTART_REQUEST packet, or x'00' in the case where no Diagnostic_Code has been specified in the RESTART_REQUEST packet.

When the Clearing_Cause field does not indicate "DTE_Originated," the Diagnostic_Code in a CLEAR_INDICATION packet is network generated. Appendix E, "Network Generated Diagnostic Codes" lists the codings for network generated diagnostics. The bits of the Diagnostic_Code are all set to '0' when no specific additional information for the clearing is supplied.

Note:

The contents of the Diagnostic_Code field do not alter the meaning of the Cause field. A DTE is not required to undertake any action on the contents of the Diagnostic_Code field. IBM SNA X.25 DTEs must report the contents of the Diagnostic_Code and Clearing_Cause fields to a higher layer of SNA. Unspecified code combinations in the Diagnostic_Code field shall not cause the DTE to refuse the cause field.

5.2.4.2 Extended Format

The extended format is used for CLEAR_REQUEST and CLEAR_INDICATION packets only when the DTE or the DCE needs to use the address field, the facility field and/or the Clear_User_Data field in conjunction with one or several optional user facilities described in §§ 6.0 and 7.0. The address field is used only when the Called_Line_Address_Modified_Notification facility is used in clearing, in response to an INCOMING_CALL or CALL_REQUEST packet. The Facility Field is used when the Charging_Information Facility is present. The Clear_User_Data Field is used in conjunction with the Fast_Select Facility.

When the extended format is used, the Diagnostic_Code field, the Address_Length fields and the Facility_Length field must be present. Optionally, the Clear_User_Data field may also be present.

- Address Block

  The address block is described in § 5.2.1.

- Facility Length Field

  The octet following the address block indicates the length of the facility field in octets. The facility length indicator is binary coded and bit 1 is the low order bit.

- Facility Field

  The facility field is present in the CLEAR_REQUEST or the CLEAR_INDICATION packet only in conjunction with one or several optional user facilities requiring some indication in this packet.

  The coding of the facility field is defined in §§ 6 and 7.

  Note:

  It is for further study whether another value should be defined, relative to the total number of octets in the packet.

The facility field contains an integral number of octets. The actual maximum length of this field depends on the facilities which are offered by the network. However, this maximum does not exceed 109 octets.

- Clear_User_Data Field

  This field may be present only in conjunction with the Fast_Select facility (see § 6.16) or the Call_Deflection_Selection facility (see § 6.25.2.2). It has a maximum length of 128 octets in the first case, of 16 or 128 octets in the second case: whether the maximum length is 16 or 128 octets when using the Call_Deflection_Selection facility is specified in § 6.25.2.2.

  Notes:

  1. Some networks require the Clear_User_Data field to contain an integral number of octets (see note in § 3).
  2. The network does not act on any part of the clear user data field. See CCITT Recommendation X.244.

5.2.5 DTE and DCE_CLEAR_CONFIRMATION Packets

Figure 5-8 illustrates the format of DTE and DCE_CLEAR_CONFIRMATION packets, in the basic or extended format.

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier (GFI)				Logical channel group number			
2	Logical channel number							
3	Packet type identifier: 0	0	0	1	0	1	1	1
4 .	Address Block (see § 5.2.1) a)							
.	Facility Length a)							
. n	Facilities a)							

a) These fields may be present only in the extended format of DCE_CLEAR_CONFIRMATION packets.

GFI - coded X001 (mod 8) or X010 (mod 128)

Figure 5-8. DTE and DCE_CLEAR_CONFIRMATION Packet Format

The extended format may be used for DCE_CLEAR_CONFIRMATION packets only in conjunction with the Charging_Information facility described in § 6.22. It is not used for DTE_CLEAR_CONFIRMATION packets.

- Address Block

  The address block is described in § 5.2.1.

  The calling and called DTE address length fields are coded with all zeros and the called and calling DTE address fields are not present.

- Facility Length Field

  The octet following the address block indicates the length of the facility field in octets. The facility length indicator is binary coded and bit 1 is the low order bit of the indicator.

- Facility Field

  The coding of the facility field is defined in §§ 6 and 7.

  The facility field contains an integral number of octets. The actual maximum length of this field depends on the facilities which are offered by the network. However, this maximum does not exceed 109 octets.

  Note:

  It is for further study whether another value should be defined, relative to the total number of octets in the packet.

5.3 Data [and Interrupt] Packets

The packets described in this section are used for transmitting data or are used with the interrupt procedure. They include the following packets:

- DATA
- INTERRUPT
- INTERRUPT_CONFIRMATION.

5.3.1 DTE and DCE_DATA Packets

Figure 5-9 on page 5-21 illustrates the format of DTE and DCE_DATA packets.

Octet	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1
1	General format identifier (GFI) Q	D	0	1	Logical channel group number			
2	Logical channel number							
3	Pr			M	Ps			0
. n	User Data							

(Modulo 8)

Octet	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1
1	General format identifier (GFI) Q	D	1	0	Logical channel group number			
2	Logical channel number							
3	Ps							0
4	Pr							M
. n	User data							

(Modulo 128)
D = Delivery confirmation bit (= '0' on SNA-to-SNA Connections).
M = More Data bit
Q = Qualifier bit

Figure 5-9. DTE and DCE_DATA Packet Format

5.3.1.1 Qualifier (Q) Bit

Bit 8 of octet 1 is the Qualifier ('Q') bit. It is used on SNA-to-SNA connections to identify 'Qualified' DATA packets as described in § 8.0.

5.3.1.2 Delivery Confirmation (D) Bit

Bit 7 of octet 1 is the Delivery Confirmation bit.

5.3.1.3 Packet Receive Sequence Number, Pr

Bits 8, 7 and 6 of octet 3, or bits 8 through 2 of octet 4 when extended, are the Packet Receive Sequence Number (Pr). Pr is binary coded and bit 6, or bit 2 when extended, is the low order bit.

5.3.1.4 More Data (M) Bit

Bit 5 in octet 3, or bit 1 in octet 4 when extended, is the More_Data mark ('M' bit):

'M=0' for no more data; and,
'M=1' for more data.

5.3.1.5 Packet Send Sequence Number, Ps

Bits 4, 3 and 2 of octet 3, or bits 8 through 2 of octet 3 when extended, are the Packet Send Sequence Number (Ps). Ps is binary coded and bit 2 is the low order bit.

5.3.1.6 User Data Field

Bits following octet 3, or octet 4 when extended, contain user data.

Note:

The User Data field field must contain an integral number of octets.

5.3.2 DTE and DCE INTERRUPT Packets

5.3.2.1 SNA-to-SNA Connections

INTERRUPT packets are not allowed on SNA-to-SNA connections. IBM SNA X.25 DTEs clear the virtual call or reset the permanent virtual circuit with the diagnostic #170 "Not Supported" upon receipt of a DCE_INTERRUPT or DCE_INTERRUPT_CONFIRMATION packet.

5.3.2.2 SNA-to-non_SNA Connections

Figure 5-10 illustrates the format of DTE and DCE INTERRUPT packets.

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier (GFI)				Logical channel group number			
2	Logical channel number							
3	Packet type identifier							
	0	0	1	0	0	0	1	1
4 . n	Interrupt user data							

GFI - Coded 0001 (modulo 8) or 0010 (modulo 128).

Figure 5-10. DTE and DCE INTERRUPT Packet Format

- Interrupt User Data Field

  Octet 4 and any following octets contain the Interrupt_User_Data. This field may contain from 1 to 32 octets.

Note:

The Interrupt User Data field must contain an integral number of octets.

5.3.3 DTE and DCE_INTERRUPT_CONFIRMATION Packets

5.3.3.1 SNA-to-SNA Connections

INTERRUPT_CONFIRMATION packets are not allowed on SNA-to-SNA connections.

5.3.3.2 SNA-to-non SNA Connections

Figure 5-11 illustrates the format of DTE and DCE_INTERRUPT_CONFIRMATION packets.

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier (GFI)				Logical channel group number			
2	Logical channel number							
3	Packet type identifier							
	0	0	1	0	0	1	1	1

GFI – Coded 0001 (modulo 8) or 0010 (modulo 128).

Figure 5-11. DTE and DCE_INTERRUPT_CONFIRMATION Packet Format

5.4 Flow Control and Reset Packets

The packets described in this section are used to control the flow of DATA packets (the DATA and REJECT packets are also used to control the flow of DATA packets) and to (re)initialize the flow of both DATA and INTERRUPT packets. They include:

- RECEIVE_READY
- RECEIVE_NOT_READY
- RESET_REQUEST
- RESET_CONFIRMATION.

5.4.1 DTE and DCE_RECEIVE_READY (RR) Packets

Figure 5-12 on page 5-24 illustrates the format of DTE and DCE_RR packets.

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier (GFI)				Logical channel group number			
	0	0	0	1				
2	Logical channel number							
3	Pr			Packet type identifier				
				0	0	0	0	1

(Modulo 8)

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier (GFI)				Logical channel group number			
	0	0	1	0				
2	Logical channel number							
3	Packet type identifier							
	0	0	0	0	0	0	0	1
4	Pr							0

(Modulo 128)

Figure 5-12. DTE and DCE_RR Packet Format

5.4.1.1 Packet Receive Sequence Number, Pr

Bits 8, 7 and 6 of octet 3, or bits 8 through 2 of octet 4 when extended, are the Packet Receive Sequence Number (Pr). Pr is binary coded and bit 6, or bit 2 when extended, is the low order bit.

5.4.2 DTE and DCE_RECEIVE_NOT_READY (RNR) Packet

Figure 5-13 on page 5-25 illustrates the format of the DTE and DCE_RNR packet.

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier (GFI)				Logical channel group number			
	0	0	0	1				
2	Logical channel number							
3	Pr			Packet type identifier				
				0	0	1	0	1

(Modulo 8)

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier (GFI)				Logical channel group number			
	0	0	1	0				
2	Logical channel number							
3	Packet type identifier							
	0	0	0	0	0	1	0	1
4	Pr							0

(Modulo 128)

Figure 5-13. DTE and DCE_RNR Packet Format

5.4.2.1 Packet Receive Sequence Number, Pr

Bits 8, 7 and 6 of octet 3, or bits 8 through 2 of octet 4 when extended, are the Packet Receive Sequence Number (Pr). Pr is binary coded and bit 6, or bit 2 when extended, is the low order bit.

5.4.3 RESET_REQUEST and RESET_INDICATION Packets

Figure 5-14 on page 5-26 illustrates the format of RESET_REQUEST and RESET_INDICATION packets.

In a DTE/DCE environment, the RESET_REQUEST packet and RESET_INDICATION packet are two different "physical" packets because of the intervening network. However, in a DTE/DTE environment, the RESET_REQUEST packet sent by one DTE is the same as the RESET_INDICATION packet received by the other DTE.

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier (GFI)				Logical channel group number			
2	Logical channel number							
3	Packet type identifier							
	0	0	0	1	1	0	1	1
4	Resetting cause							
5	Diagnostic code (This field is mandatory on SNA-to-SNA Connections (see Appendix H))							

GFI – Coded 0001 (modulo 8) or 0010 (modulo 128).

Figure 5-14. RESET_REQUEST and RESET_INDICATION Packet Format

5.4.3.1 Resetting Cause Field

Octet 4 is the Resetting_Cause field and contains the reason for the reset.

In RESET_REQUEST packets, the Resetting_Cause field must be set by the DTE to one of the following values:

```
  bits:  8  7  6  5  4  3  2  1
 value:  0  0  0  0  0  0  0  0
    or:  1  x  x  x  x  x  x  x where each x may be independently
                                 set to '0' or '1' by the DTE.
```

To be in compliance with ISO 8208, each 'x' must be set to '0' by the DTE. Other values for X are for use by Private Packet Switched Data Networks (which appear as DTEs to the public network).

The DCE will prevent values of the resetting cause field other than those shown above from reaching the other end of the virtual call or permanent virtual circuit by either accepting the RESET_REQUEST packet and forcing the Resetting_Cause field to all zeros in the corresponding RESET_INDICATION packet, or considering the RESET_REQUEST as an error and following the procedure described in Appendix C, "Packet Layer DCE Actions."

The coding of the Resetting_Cause field in a RESET_INDICATION packet is given in Table 19. In a DTE/DCE environment, a DTE, in order to allow for possible later extensions to Table 19, must be able to accept any value in the Resetting Cause Field in a RESET_INDICATION packet. In a DTE/DTE environment, a DTE may either handle a resetting cause other than "DTE Originated" as it does in a DTE/DCE environment (i. e., process the packet normally) or treat it as an error. In the latter case, the Packet Layer transmits a RESET_REQUEST packet with a cause indicating "DTE Originated" and the diagnostic "Improper Cause Code From DTE."

Table 19: Coding of the Resetting Cause field in RESET_INDICATION Packets — Bits	8 7 6 5	4 3 2 1
DTE Originated	0 0 0 0	0 0 0 0
DTE Originated	1 0 0 0	0 0 0 0
Out of order	X 0 0 0	0 0 0 1
Remote procedure error	X 0 0 0	0 0 1 1
Local procedure error	X 0 0 0	0 1 0 1
Network congestion	X 0 0 0	0 1 1 1
Remote DTE operational	X 0 0 0	1 0 0 1
Network operational	X 0 0 0	1 1 1 1
Incompatible destination	X 0 0 1	0 0 0 1
Network out of order	X 0 0 1	1 1 0 1
Gateway-detected Procedure Error	1 1 0 0	0 0 0 1
Gateway Congestion	1 1 0 0	0 0 1 1
Gateway Operational	1 1 0 0	0 1 1 1

£-Applicable to permanent virtual circuits only.
The bit indicated as "X" set to 0 indicates a resetting cause generated by a public data network and set to 1 indicates a resetting cause generated by a private network.

5.4.3.2 Diagnostic Code

Octet 5 is the Diagnostic_Code field (mandatory on SNA-to-SNA connections) and contains additional information on the reason for the reset.

Cause and Diagnostic Codes generated by IBM SNA X.25 DTEs for RESET_REQUEST packets are shown in Appendix H, "DTE-Generated Diagnostic Codes."

In a RESET_REQUEST packet, the Diagnostic Code Field is required, even if it indicates no additional information.

In a RESET_INDICATION packet, if the Resetting_Cause field indicates "DTE Originated," the Diagnostic_Code has been passed unchanged from the remote DTE. In a RESET_INDICATION packet, if the Resetting_Cause field does not indicate "DTE Originated", then the Diagnostic Code Field is network generated. If the DTE requesting a reset has not provided a Diagnostic_Code in its RESET_REQUEST packet, then the bits of the Diagnostic Code in the resulting RESET_INDICATION packet will be x'00'.

If a RESET_INDICATION packet results from a RESTART_REQUEST packet, the value of the Diagnostic_Code will be that specified in the RESTART_REQUEST, or x'00' in the case where no Diagnostic_Code has been specified in the RESTART_REQUEST packet.

When the Resetting_Cause field does not indicate "DTE Originated," the Diagnostic_Code in RESET_INDICATION packets is network generated.

Appendix E, "Network Generated Diagnostic Codes" lists the codings for network generated diagnostics. The bits of the Diagnostic_Code field are all set to '0' when no specific additional information for the reset is supplied.

Note:

The contents of the Diagnostic_Code field do not alter the meaning of the Cause field. A DTE is not required to undertake any action on the contents of the Diagnostic_Code field. IBM SNA X.25 DTEs must report the contents of the Diagnostic Code and Resetting Cause fields to a higher level of SNA. An unspecified diagnostic code shall not cause the DTE to reject the cause field.

5.4.4 DTE and DCE_RESET_CONFIRMATION Packets

Figure 5-15 illustrates the format of DTE and DCE_RESET_CONFIRMATION packets.

Octet	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1
1	General format identifier (GFI)				Logical channel group number			
2	Logical channel number							
3	Packet type identifier							
	0	0	0	1	1	1	1	1

GFI – Coded 0001 (modulo 8) or 0010 (modulo 128).

Figure 5-15. DTE and DCE_RESET_CONFIRMATION Packet Format

5.5 Restart Packets

5.5.1 RESTART_REQUEST AND RESTART_INDICATION PACKETS

Figure 5-16 on page 5-29 illustrates the format of RESTART_REQUEST and RESTART_INDICATION packets.

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier (GFI)				Logical channel group number 0	0	0	0
2	Logical channel number 0	0	0	0	0	0	0	0
3	Packet type identifier 1	1	1	1	1	0	1	1
4	Restarting cause							
5	Diagnostic code (This field is mandatory on SNA-to-SNA Connections (see Appendix H))							

GFI - Coded 0001 (modulo 8) or 0010 (modulo 128).

Figure 5-16. RESTART_REQUEST and RESTART_INDICATION Packet Format

In a DTE/DCE environment, the RESTART_REQUEST packet and RESTART_INDICATION packet apply only at a local DTE/DCE interface. However, in a DTE/DTE environment, the RESTART_REQUEST packet sent by one DTE is the same as the RESTART_INDICATION packet received by the other DTE.

5.5.1.1 Restarting Cause Field

Octet 4 is the Restarting_Cause field and contains the reason for the restart.

In RESTART_REQUEST packets, the Restarting_Cause field should be set by the DTE to one of the following values:

bits:	8	7	6	5	4	3	2	1	
value:	0	0	0	0	0	0	0	0	
or:	1	x	x	x	x	x	x	x	where each 'x' may be independently set to '0' or '1' by the DTE

To be in compliance with ISO 8208, each 'x' must be set to '0' by the DTE.

The DCE will prevent values of the restarting cause field other than those shown above from reaching the other end of the virtual call or permanent virtual circuit by either accepting the RESTART_REQUEST packet and forcing the Restarting_Cause field to all zeros in the corresponding RESTART_INDICATION packet, or considering the RESTART_REQUEST as an error and following the procedure described in Appendix C.

In a DTE/DCE environment, a DTE, in order to allow for possible later extensions to Table 20, must be able to accept any value in the Restarting Cause Field in a RESTART_INDICATION packet. In a DTE/DTE environment, a DTE may either handle a restarting cause other than "DTE Originated" as it does in a DTE/DCE environment (i.e., process the packet normally) or treat it as an error. In the latter case, the Packet Layer transmits a RESTART_REQUEST packet with a cause indicating "DTE Originated" and the diagnostic "Improper Cause Code from DTE."

The coding of the Restarting_Cause field in RESTART_INDICATION packets is given in Table 20.

Table 20: Coding of the Restarting Cause field in RESTART_INDICATION packets

Bits	8 7 6 5 4 3 2 1
DTE Originated*	0 0 0 0 0 0 0 0
DTE Originated*	1 0 0 0 0 0 0 0
Local Procedure Error	0 0 0 0 0 0 0 1
Network congestion	0 0 0 0 0 0 1 1
Network operational	0 0 0 0 0 1 1 1
Registration/Cancellation Confirmed-£	0 1 1 1 1 1 1 1

£–May be received only if the optional On-Line_Facility_Registration facility is used.
*–These restarting causes apply only to a DTE/DTE environment. All others apply only to a DTE/DCE environment.

5.5.1.2 Diagnostic Code

Octet 5 contains the Diagnostic_Code which provides additional information on the reason for the restart.

In a RESTART_REQUEST packet, the Diagnostic Code Field is required, even if it indicates no additional information. Diagnostic Codes generated by IBM SNA X.25 DTEs for RESTART_REQUEST packets are given in Appendix H, "DTE-Generated Diagnostic Codes." The Diagnostic Code is passed to the corresponding DTEs as Diagnostic_Code of a RESET_INDICATION packet on permanent virtual circuits or a CLEAR_INDICATION packet on virtual calls.

The coding of the Diagnostic_Code field in a RESTART_INDICATION packet is given in Appendix E. The contents of the Diagnostic_Code field is set to x'00' when no specific additional information for the restart is supplied.

Note:

The contents of the Diagnostic Code field do not alter the meaning of the Cause field. A DTE is not required to undertake any action on the contents of the Diagnostic_Code field. IBM SNA X.25 DTEs must report the contents of the Diagnostic Code field to a higher layer of SNA. Unspecified code combinations in the Diagnostic_Code field shall not cause the DTE to not accept the cause field.

5.5.2 DTE and DCE_RESTART_CONFIRMATION Packets

Figure 5-17 illustrates the format of DTE and DCE_RESTART_CONFIRMATION packets.

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier (GFI)				Logical channel group number			
					0	0	0	0
2	Logical channel number							
	0	0	0	0	0	0	0	0
3	Packet type identifier							
	1	1	1	1	1	1	1	1

GFI – Coded 0001 (modulo 8) or 0010 (modulo 128).

Figure 5-17. DTE and DCE_RESTART_CONFIRMATION Packet Format

5.6 Diagnostic Packet

Figure 5-18 on page 5-32 illustrates the format of the DIAGNOSTIC packet.

All DTEs should be capable of receiving a DIAGNOSTIC packet. The DIAGNOSTIC packet may be used in a DTE/DCE environment, and then only to be sent by a DCE to a DTE. The DIAGNOSTIC packet may be originated by a DTE only in a DTE/DTE environment provided its generation can be suppressed when connected to a network.

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier (GFI)				Logical channel group number 0	0	0	0
2	Logical channel number 0	0	0	0	0	0	0	0
3	Packet type identifier 1	1	1	1	0	0	0	1
4	Diagnostic code							
5 . n	Diagnostic explanation (see Note)							

GFI – Coded 0001 (modulo 8) or 0010 (modulo 128).

Note: The diagnostic explanation field is required to be an integral number of octets in length.

Figure 5-18. DIAGNOSTIC Packet Format

5.6.1 Diagnostic Code Field

Octet 4 is the diagnostic code and provides information on the error condition which resulted in the transmission of the DIAGNOSTIC packet. Diagnostic Codes are given in Appendix E, "Network Generated Diagnostic Codes."

5.6.2 Diagnostic Explanation Field

When the DIAGNOSTIC packet is issued as a result of the reception of an erroneous packet from the DTE (see Tables C-1 and C-2 in Appendix C, "Packet Layer DCE Actions"), this field contains the first three octets of header information from the erroneous DTE packet. If the packet contains less than 3 octets, this field contains whatever bits were received padded to an integral number of octets with '0' bits.

When the DIAGNOSTIC packet is issued as a result of a DCE time-out (see Table D-1 in Appendix D, "DCE Time-outs and DTE Time-limits"), the Diagnostic Explanation field contains 2 octets coded as follows:

1. Bits 8, 7, 6 and 5 of the first octet contain the General Format Identifier for the DTE/DCE interface.
2. Bits 4 to 1 of the first octet and bits 8 to 1 of the second octet are x'000' for expiration of time-out T10; and, give the identifier of the logical channel on which the time-out occurred for expiration of time-out T12 or T13.

5.7 Packets required for optional user facilities

5.7.1 DTE_REJECT (REJ) Packet for the Packet Retransmission Facility

The DTE_REJ packet, used in conjunction with the Packet Retransmission facility described in § 6.4 is not used in SNA X.25 DTEs.

5.7.2 Registration Packets for the On-Line Facility Registration Facility

5.7.2.1 REGISTRATION_REQUEST Packet

Figure 5-19 illustrates the format of the REGISTRATION_REQUEST packet.

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier (GFI)				Logical channel group number 0	0	0	0
2	Logical channel number 0	0	0	0	0	0	0	0
3	Packet Type Identifier 1	1	1	1	0	0	1	1
4	DTE Address Length				DCE Address Length			
5	DCE and DTE Address(es) (see Note)							
.					0	0	0	0
.	Registration Length							
. . n	Registration							

GFI – Coded '0001' (modulo 8) or '0010' (modulo 128)

Note: The figure is drawn assuming the total number of address digits present is odd.

Figure 5-19. REGISTRATION_REQUEST Packet Format

- Address Length Fields

  Octet 4 consists of the field length indicators for the DTE and DCE addresses. Bits 4, 3, 2 and 1 indicate the length of the DCE (or remote DTE if DTE/DTE) address in semi-octets. Bits 8, 7, 6 and 5 indicate the length of the DTE address in semi-octets. Each address length indicator is binary coded and bit 1 or 5 is the low order bit of the indicator.

  These fields are coded with all zeros under the procedures of this specification.

- Address Field

Octet 5 and the following octets consist of the DCE address, when present, and the DTE address, when present.

Each digit of an address is coded in a semi-octet in binary coded decimal with bit 5 or bit 1 being the low order bit of the digit.

Starting from the high order digit, the address is coded in octet 5 and consecutive octets with two digits per octet. In each octet, the higher order digit is coded in its 8, 7, 6 and 5.

The address field shall be rounded up to an integral number of octets by inserting zeros in bits 4, 3, 2 and 1 of the last octet of the field when necessary.

This field is not present under the procedures in this specification.

- Registration Length Field

> The octet following the address field indicates the length of the
> registration field in octets. The registration length indicator is binary coded and bit 1 is the low order bit of the indicator.

- Registration Field

  The registration field is present only when the DTE wishes to request the DCE to agree to, or to stop a previous agreement for, an optional user facility.

  The coding of the registration field is defined in § 7.3.

  The registration field contains an integral number of octets. The actual maximum length of this field depends on the network. However, this maximum does not exceed 109 octets.

5.7.2.2 Registration Confirmation Packet

Figure 5-20 illustrates the format of the REGISTRATION_CONFIRMATION packet.

Octet	Bits 8	7	6	5	4	3	2	1
1	General format identifier (GFI)				Logical channel group number			
					0	0	0	0
2	Logical channel number							
	0	0	0	0	0	0	0	0
3	Packet Type Identifier							
	1	1	1	1	0	1	1	1
4	Cause							
5	Diagnostic							
6	DTE Address Length				DCE Address Length			
.	DCE and DTE Address(es) (see Note)							
.					0	0	0	0
.	Registration Length							
.	Registration							
n								

GFI – Coded '0001' (modulo 8) or '0010' (modulo 128)

Note: The figure is drawn assuming the total number of address digits present is odd.

Figure 5-20. REGISTRATION_CONFIRMATION Packet Format

- Cause Field

Octet 4 is the cause field and contains the cause of the failure in negotiation of facilities or an indication that the registration field was verified by the DCE.

The coding of the cause field in the REGISTRATION_CONFIRMATION packet is shown in Table 21.

Table 21: Coding of the Cause field in REGISTRATION_CONFIRMATION Packets

Bits	8 7 6 5 4 3 2 1
Registration/Cancellation Confirmed	0 1 1 1 1 1 1 1
Invalid Facility Request	0 0 0 0 0 0 1 1
Local Procedure Error	0 0 0 1 0 0 1 1
Network Congestion	0 0 0 0 0 1 0 1

- Diagnostic Code

  Octet 5 is the diagnostic code and contains additional information on the reason for the failure of facilities registration.

  Appendix E lists the coding for diagnostics. The bits of the diagnostic code are all set to '0' when negotiation is successful, or when no additional information is supplied.

- Address Length Fields

  Octet 6 consists of the field length indicators for the DTE and DCE addresses. Bits 4, 3, 2 and 1 indicate the length of the DCE (or remote DTE if DTE/DTE) address in semi-octets. Bits 8, 7, 6 and 5 indicate the length of the DTE address in semi-octets. Each address length indicator is binary coded and bit 1 or bit 5 is the low order bit of the indicator.

  These fields are coded with all zeros under the procedures of this specification.

- Address Field

  Octet 7 and the following octets consist of the DCE address, when present, and the DTE address, when present.

  Each digit of an address is coded in a semi-octet in binary coded decimal with bit 5 or bit 1 being the low order bit of the digit.

  Starting from the high order digit, the address is coded in octet 7 and consecutive octets with two digits per octet. In each octet, the higher order digit is coded in bits 8, 7, 6 and 5.

  The address field shall be rounded up to an integral number of octets by inserting zeros in bits 4, 3, 2 and 1 of the last octet of the field when necessary.

  This field is not present under the procedures in this specification.

- Registration Length Field

The octet following the address field indicate the length of the registration field in octets. The registration length indicator is binary coded and bit 1 is the low order bit of the indicator.

- Registration Field

  The registration field is used to indicate which optional user facilities are available, and which are currently in effect.

  The coding of the registration field is defined in § 7.3.

  The registration field contains an integral number of octets. The actual maximum length of this field depends on the network. However, this maximum does not exceed 109 octets.

Chapter 6. Procedures for Optional User Facilities (Packet Layer)

6.1 On-Line_Facility_Registration

On-Line_Facility_Registration is an optional user facility agreed upon for a period of time. This facility, if subscribed to, permits the DTE at any time to request registration of facilities, or obtain current values of facilities as understood by the DCE, by transferring across the DTE/DCE interface a REGISTRATION_REQUEST packet. In a DTE/DTE environment, separate agreement to use this facility is required for each direction of registration-procedure initiation. For initiation of the registration procedure in a given direction, use of this facility permits the initiating DTE to transmit REGISTRATION_REQUEST packets and requires the responding DTE to process received REGISTRATION_REQUEST packets, as described below. In a DTE/DCE environment, the DTE is always the initiator of the registration procedure while the DCE is always the responder.

6.1.1 General Procedures for On-Line_Facility_Registration

This section describes the general procedures for using the On-Line_Facility_Registration Facility. The registration procedure itself does not affect the state of any logical channel. Specific procedures depend on the facility to be negotiated and are discussed in Section 6.1.2.

6.1.1.1 Requesting Facility Registration

This section applies to a DTE only when it acts as an initiator for the registration procedure.

A DTE requests registration of optional user facilities and/or obtains the current values of optional user facilities, as applicable, by transmitting across the interface a REGISTRATION_REQUEST packet and by starting the Registration Request Response Timer (T28).

A REGISTRATION_REQUEST packet may be sent without attempting to register any optional user facilities (i. e., without a Registration Field) to obtain the current values of the applicable optional user facilities or to avoid requesting facilities or values of facilities that are not available.

Having sent a REGISTRATION_REQUEST packet, the DTE should wait for the REGISTRATION_CONFIRMATION packet before sending a CALL_REQUEST packet.

The failure to receive a REGISTRATION_CONFIRMATION packet before expiration of T28 after transmission of a REGISTRATION_REQUEST packet is considered an error. The registration procedure is retried up to a maximum number of times R28. After this, the Packet Layer notifies the appropriate entity that it has not received a confirmation of the registration procedure.

6.1.1.2 Processing a Facility Registration Request

This section always applies to a DCE when the registration procedure is used. It applies to a DTE only in a DTE/DTE environment when it acts as a responder for the registration procedure.

The DCE or DTE will, in response to a REGISTRATION_REQUEST packet (even if the packet has no Registration field), report the availability and the current value of all facilities applicable to the interface, by transferring a REGISTRATION_CONFIRMATION packet across the interface. Optional facilities which are not offered by the network will not be reported in the REGISTRATION_CONFIRMATION packet.

When a REGISTRATION_CONFIRMATION packet is returned, the facilities values shown are in effect for any subsequent virtual calls. The values of the Extended Packet Sequence Numbering, Packet Retransmission and D-bit Modification facilities and the allocation of logical channel type ranges can be modified only when there are no virtual calls (i.e., all logical channels used for virtual calls are in state p1). When these facilities take effect and when there is one or more logical channels assigned to permanent virtual circuits, a restart procedure is initiated. In a DTE/DCE environment, the DCE transmits a RESTART_INDICATION packet with a cause indicating "Registration/Cancellation_Confirmed" and the diagnostic "No Additional Information" in order to change the values for the permanent virtual circuits at the interface. At the remote end of each permanent virtual circuit, the corresponding RESET_INDICATION packet is sent by the DCE with the cause "Remote DTE Operational" and the diagnostic "No Additional Information." In a DTE/DTE environment, the DTE transmitting a REGISTRATION_CONFIRMATION packet also transmits a RESTART_REQUEST packet with a cause indicating "DTE Originated" and the diagnostic "Registration/Cancellation_Confirmed."

If a requested value of a particular facility is not allowed, the DCE or DTE (DTE/DTE environment) shall report in the REGISTRATION_CONFIRMATION packet:

- if the facility has a Boolean value, the value allowed;
- if the value is greater than the maximum allowed value of that facility, the maximum allowed value; or,
- if the value is less than the minimum allowed value of that facility, the minimum allowed value.

The REGISTRATION_CONFIRMATION packet shall also contain an appropriate cause code. The DTE may choose to accept the value reported by the DCE or to attempt to negotiate another value for the requested facility.

If the DCE cannot make all the modifications requested in a REGISTRATION_REQUEST packet, it will not alter the values of some facilities. Circumstances in which the DCE cannot make all of the modifications requested include:

- conflict in facilities settings; and,
- when the interface has at least one virtual call established when attempting to negotiate those facilities that require all virtual call

logical channels to be in state p1 (including the collision of an INCOMING_CALL packet and a REGISTRATION_REQUEST packet).

The DTE should wait for the REGISTRATION_CONFIRMATION packet before sending a CALL_REQUEST packet, or sending a packet on a permanent virtual circuit.

For every optional user facility, Appendix F, "On-Line Registration Facility Applicability" indicates:

- if the value of the facility may be negotiated;
- if REGISTRATION_CONFIRMATION packets indicate whether or not the facility is supported by the DCE; and,
- if the value of the facility may be altered by the DTE only when every logical channel used for virtual calls is in state p1 or in any packet layer state.

Indication in REGISTRATION_CONFIRMATION packet of whether NUI override facility is supported by the networks is for further study by the CCITT.

A fault condition within the network may affect the facilities previously negotiated by means of REGISTRATION packets. In this situation the DCE initiates a restart procedure to inform the DTE of the failure.

A restart procedure initiated by the DTE does not affect the facilities values. When the DCE initiates the restart procedure with the cause "Local Procedure Error," the facilities values are not affected. When the DCE initiates the restart procedure with the cause "Network Congestion" or "Network Operational," the values of facilities previously negotiated may be affected. When the DCE initiates the restart procedure with the cause "Registration/Cancellation_Confirmed," the facilities values are as set by the related registration procedure.

If in a DTE/DTE environment, a DTE receives a REGISTRATION_REQUEST packet after having transmitted its own REGISTRATION_REQUEST packet, then the registration procedure is considered cancelled with no effect and no REGISTRATION_CONFIRMATION packet is returned. The DTE may transmit another REGISTRATION_REQUEST packet after some randomly chosen time delay.

6.1.1.3 Receiving a Response to Facility Registration

This section applies to a DTE only when it acts as an initiator for the registration procedure.

The REGISTRATION_CONFIRMATION packet received in response to a REGISTRATION_REQUEST packet, which was sent either with or without a Registration Field, always contains information regarding the availability and the current values of all optional user facilities applicable to the interface. The DTE may choose either to accept the values reported in this packet or to attempt to negotiate other values by transmitting another REGISTRATION_REQUEST packet across the interface.

The facility values reported in a REGISTRATION_CONFIRMATION packet are in effect for any subsequent virtual calls. In addition, when there is one or more Permanent Virtual Circuits at the interface, the values of those facilities that can be modified only when there are no existing virtual calls (i. e., all logical channels used for virtual calls are in the READY state - p1) take effect at the completion of a restart procedure. In a DTE/DCE environment, the DTE will also receive a RESTART_INDICATION packet from the DCE with a cause indicating "Registration/Cancellation_Confirmed" and the diagnostic "No Additional Information." In a DTE/DTE environment, the DTE receiving a REGISTRATION_CONFIRMATION packet will also receive a RESTART_INDICATION packet with a cause indicating "DTE Originated" and the diagnostic "Registration/Cancellation_Confirmed." In either case, a RESTART_CONFIRMATION packet is transmitted in response to the RESTART_INDICATION packet.

Those optional user facilities for which a modification was requested in the REGISTRATION_REQUEST packet but for which there is no corresponding facility indicated in the REGISTRATION_CONFIRMATION packet are not supported or are not permitted to be negotiated with the On-Line_Facility_Registration Facility.

6.1.1.4 Effects of Fault Conditions on Registration

A fault condition in a DTE that acts as an initiator for the registration procedure may affect the values of the optional user facilities previously registered through the registration procedure. In this case, the DTE should transmit a REGISTRATION_REQUEST packet without a Registration Field to ascertain the current values of the optional user facilities as understood by the interfacing DCE (or DTE if DTE/DTE).

A fault condition within the network may affect the values of the optional user facilities previously registered through the registration procedure. In this case, the DCE initiates a restart procedure to inform the DTE of the failure. When the DCE initiates a restart procedure with the cause "Network Congestion" or "Network Operational", the facilities values previously negotiated may be affected. (When the DCE initiates a restart procedure with the cause "Local Procedure Error", the facilities are not affected.

A fault condition within a DTE that acts as a responder for the registration procedure in a DTE/DTE environment may affect the values of the optional user facilities previously registered through the registration procedure. In this case, the DTE initiates a restart procedure with a cause of "DTE Originated" to inform the other DTE of the failure. If the diagnostic is "DTE Operational" or "DTE Not Operational", then the facilities values previously negotiated may be affected; otherwise the facilities values are not affected.

When a DTE that acts as an initiator for the registration procedure receives a RESTART_INDICATION packet indicating that the facilities values may have been affected, it should send a REGISTRATION_REQUEST packet without a Registration Field to verify the facilities values previously negotiated. A second REGISTRATION_REQUEST packet may be sent, if necessary to negotiate particular facilities.

6.1.2 Registration Procedures for Specific Optional User Facilities

The registration procedure for a specific optional user facility depends on the facility. Table 21-A classifies, for the purposes of registration, the optional user facilities according to the registration-procedure requirements applying to them.

The absence of a registration-facility in a REGISTRATION_REQUEST packet means no modification to the previous agreement is desired for the concerned facilities.

The absence of a registration-facility in a REGISTRATION_CONFIRMATION packet means that the concerned facilities are not supported or are not permitted to be negotiated with the On-Line_Facility_Registration Facility.

TABLE 21-A Part 1 of 2

CLASSIFICATION OF OPTIONAL USER FACILITIES FOR REGISTRATION

Class And Characteristics Of Optional User Facilities (Note 1) (Reference Section)	Optional User Facility (Note 2)	Registration Facility Used In:			Registration Applicable to DTE\DTE Operation? (Note 4)
		REG.REQ.* Packet To Request Values For Facilities	REG.CONF.* Packet To Indicate Current Values of Facilities	REG.CONF.* Packet To Indicate Facility Available In DCE	
Class 1: facilities for which registration does not apply (Section 6.1.2.1.)	On-line Facility Registration	–	–	–	–
	Closed User Group Related Facilities	–	–	–	–
	Bilateral Closed User Group Related Facilities	–	–	–	–
	Fast Select	–	–	–	–
	Network User Ident.	–	–	–	–
	RPOA Selection (per-interface basis)	–	–	–	–
	Hunt Group	–	–	–	–
	Call Redirection	–	–	–	–
	Call Redirection Notification	–	–	–	–
	Transit Delay Selection & Indication	–	–	–	–
Class 2: facilities that cannot be negotiated but whose values can be ascertained (Section 6.1.2.3)	Local Charging Prevention	–	a	–	No
Class 3: facilities that apply on a per virtual call basis and whose availability can be ascertained by a DTE (these correspond to certain Additional facilities that a DTE may use with no need for prior agreement) (Section 6.1.2.3)	Reverse Charging	–	–	b	No
	Charging Info (per virtual call)	–	–	b	No
	RPOA Selection (per virtual call)	–	–	b	No
	Called Line Address Modified Notification	–	–	b	No

TABLE 21-A Part 2 of 2 CLASSIFICATION OF OPTIONAL USER FACILITIES FOR REGISTRATION					
Class And Characteristics Of Optional User Facilities (Note 1) (Reference Section)	Optional User Facility (Note 2)	Registration Facility Used In: REG.REQ.* Packet To Request Values For Facilities	REG.CONF.* Packet To Indicate Current Values of Facilities	REG.CONF.* Packet To Indicate Facility Available In DCE	Registration Applicable to DTE\DTE Operation? (Note 4)
Class 4: facilities that are always available & whose use can be invoked/revoked by a DTE at any time (these correspond to certain Essential facilities whose use a DTE & DTE must agree to for a period of time) (Section 6.1.2.4)	Incoming Calls Barred	c	c	–	Yes
	Outgoing Calls Barred	c	c	–	Yes
	Flow Control Parm Negotiation	c	c	–	Yes
	Throughput Class Negotiation	c	c	–	Yes
	Fast Select Acceptance	c	c	–	Yes
Class 5: facilities that apply to the interface & whose availability for negotiation can be ascertained & a value negotiated (these correspond to certain Additional facilities whose use a DTE & DCE must agree to for a period of time) (Section 6.1.2.5)	Reverse Charging Acceptance	c	c	b	No
	Charging Info (per-interface basis)	c	c	b	No
	Nonstandard Default Packet Sizes	e	e	b	Yes
	Nonstandard Default Window Sizes	f	f	b	Yes
	Default Throughput Classes Assignment	g	g	b	Yes
	Logical Channel Ranges (Note 2)	Note 5 h	h	b	Yes
	Extended Packet Sequence Numbering	d	d	b	Yes
	Packet Retransmiss.	d	d	b	Yes
	D-bit Modification	d	d	b	No

* REG.REQ = REGISTRATION_REQUEST packet
* REG.CONF = REGISTRATION_CONFIRMATION packet

1. The categorization of facilities as Essential or Additional is given in Table 9.
2. In this section, the term "optional user facility" includes Logical Channel Ranges parameters. These parameters are inclusive of the One-way_Logical_Channel_Outgoing and One-way_Logical_Channel_Incoming Facilities. The values subject to negotiation are the associated parameters (i. e., boundary points) of the one-way incoming logical channels (LIC and HIC), two-way logical channels (LTC and HTC), and one-way outgoing logical channels (LOC and HOC).

3. The registration procedure makes use of eight "registration-facilities." These registration-facilities, which are used only in support of the registration procedure, are:

   a. the "Non-negotiable Facilities Values" Registration-Facility;

   b. the "Availability Of Facilities" Registration-Facility;

   c. the "Facilities That May Be Negotiated At Any Time" Registration-Facility;

   d. the "Facilities That May Be Negotiated Only When All Logical Channels Used For Virtual Calls Are In State p1" Registration Facilities;

   e. the "Nonstandard Default Packet Sizes" Registration Facilities;

   f. the "Nonstandard Default Window Sizes" Registration Facilities;

   g. the "Default Throughput Classes Assignment" Registration Facilities;

   h. the "Logical Channel Types Ranges" Registration Facilities;

   The registration-facilities in (e), (f), and (g) above are used to negotiate the optional user facilities with the same name. However, the registration- facility is distinct from the optional user facility.

4. "No" means that the corresponding bit in the registration-facility must be 0.

5. Values for these facilities may be requested only when all logical channels used for virtual calls are in state p1.

DTEs should ignore registration-facilities that they do not support or do not know.

6.1.2.1 Class 1 Optional User Facilities

The registration procedure does not apply to optional user facilities in Class 1. These optional user facilities are:

- those facilities for which negotiation is not permitted:
  - On-Line_Facility_Registration,
  - Closed_User_Group Related Facilities,
  - Bilateral_Closed_User_Group Related Facilities,
  - Network_User_Identification, and
  - Hunt_Group;
- those facilities for which negotiation is not needed (these are Essential facilities that a DTE may request on a per virtual call basis at any time):
  - Fast_Select, and
  - Transit_Delay_Selection_And_Indication
- those facilities that only a DCE uses:
  - Call_Redirection or Call_Deflection_Notification; and

- those facilities for which the applicability of the registration procedure is for further study by CCITT:
  - RPOA_Selection (per-interface basis), and
  - Call_Redirection; and
  - Call_Deflection Related Facilities.

6.1.2.2 Use of Registration-Facilities Applicable to Class 2 Optional User Facilities

There is one Class 2 optional user facility: Local_Charging_Prevention.

The registration procedure can be used only to ascertain the values of Class 2 optional use facilities. It cannot be used to invoke or revoke these facilities.

To ascertain the values of Class 2 optional user facilities, the DTE must transmit across the DTE/DCE interface a REGISTRATION_REQUEST packet with or without any registration-facilities. The "Non-negotiable Facilities Values" Registration-Facility is used by the DCE in a REGISTRATION_CONFIRMATION packet to specify the values of the Class 2 optional user facilities.

6.1.2.3 Use of Registration-Facilities Applicable to Class 3 Optional User Facilities

There are four Class 3 optional user facilities:

1) Reverse_Charging;
2) Charging_Information (per virtual call basis);
3) RPOA_Selection (per virtual call basis); and
4) Called_Line_Address_Modified_Notification.

The registration procedure can be used only to determine the availability for use of Class 3 optional user facilities. It is not used to invoke or revoke these facilities.

To ascertain the availability for use of Class 3 optional user facilities, the DTE must transmit across the DTE/DCE interface a REGISTRATION_REQUEST packet with or without any registration facilities. The "Availability of Facilities" Registration-Facility is used by the DCE in a REGISTRATION_CONFIRMATION packet to specify whether optional user facilities are available for use by the DTE. If this registration-facility indicates that a Class 3 optional user facility is available for use, then the DTE may request it on subsequent Virtual Calls.

6.1.2.4 Use of Registration-Facilities Applicable to Class 4 Optional User Facilities

There are five Class 4 optional user facilities:

1) Incoming_Calls_Barred;
2) Outgoing_Calls_Barred;
3) Flow_Control_Parameter_Negotiation;
4) Throughput_Class_Negotiation; and

5) Fast_Select Acceptance.

The "Facilities That May Be Negotiated At Any Time" Registration-Facility is used by a DTE in a REGISTRATION_REQUEST packet to specify whether optional user facilities are to be invoked or revoked. (The REGISTRATION_REQUEST packet transmitted across the interface may also contain other registration-facilities.)

The "Facilities That May Be Negotiated At Any Time" Registration-Facility is used by the DCE or DTE in a REGISTRATION_CONFIRMATION packet to specify whether optional user facilities are invoked or revoked. If this registration-facility indicates that the Flow_Control_Parameter_Negotiation and/or Throughput_Class_Negotiation Facilities are invoked, then the DTE may negotiate them on subsequent virtual calls. If this registration-facility indicates that the Incoming_Calls_Barred, Outgoing_Calls_Barred, and/or Fast_Select_Acceptance Facilities are invoked, then they are in effect for subsequent virtual calls.

Notes:

Invocation/revocation of the Incoming_Calls_Barred and/or Outgoing_Calls_Barred Facilities does not alter the values of the parameters for ranges of logical channel types (LIC, HIC, LTC, HTC, LOC, and HOC).

In a DTE/DTE environment, the registration procedure may be applied to the Incoming_Calls_Barred, Outgoing_Calls_Barred, and Fast_Select_Acceptance Facilities (these facilities do not usually apply in this environment). The Incoming_Calls_Barred and Outgoing_Calls_Barred Facilities may be invoked/revoked to control virtual call initiation on the DTE/DTE interface. Negotiation of the Fast_Select_Acceptance Facility may be used to determine the ability of both DTEs to support the Fast_Select_Acceptance Facility when used during virtual call setup.

6.1.2.5 Use of Registration-Facilities Applicable to Class 5 Optional User Facilities

There are eight Class 5 optional user facilities:

1) Extended_Packet_Sequence_Numbering (the exact method for negotiating this facility is being studied by the CCITT). (Class 5.1);

2) D-bit_Modification (Class 5.1);

3) Packet_Retransmission (Class 5.1);

4) Nonstandard_Default_Packet_Sizes (Class 5.2);

5) Nonstandard_Default_Window_Sizes (Class 5.2);

6) Default_Throughput_Class_Assignment (Class 5.2);

7) Reverse_Charging_Acceptance (Class 5.1); and

8) Charging_Information (per-interface basis) (Class 5.1).

The set of logical channel range parameters (LIC, HIC, LTC, HTC, LOC, and HOC) is also included in Class 5.2. This set encompasses the

One-way_Logical_Channel_Outgoing and
One-way_Logical_Channel_Incoming Facilities.

Notes:

1. Class 5 optional user facilities are further categorized by whether they have a boolean value (Class 5.1) or a numeric value (Class 5.2).

2. In this section, "optional user facilities" also refers to the set of parameters associated with the different logical channel types.

3. The registration procedure for the Nonstandard_Default_Packet_Sizes, Assignment Facilities applies to the use of these facilities for virtual calls only. The registration procedure does not apply to the use of these facilities for Permanent Virtual Circuits.

To ascertain the availability for negotiation of Class 5 optional user facilities, the DTE transmits across the interface a REGISTRATION_REQUEST packet with or without any registration facilities. The "Availability Of Facilities" Registration-Facility is used by the DCE or DTE in a REGISTRATION_CONFIRMATION packet to specify whether optional user facilities are available for negotiation by the DTE. If this registration-facility indicates that a Class 5 optional user facility is available for negotiation, then the DTE may negotiate a value for it in a subsequent REGISTRATION_REQUEST packet.

The procedure for registering a value for such a facility is dependent on whether the facility has a boolean value (Class 5.1) or a numeric value (Class 5.3).

Note:

A DTE may attempt to register a value for a Class 5 optional user facility without ascertaining whether it is available for negotiation.

To register a value for one or more optional user facilities in this class, the DTE transmits across the interface a REGISTRATION_REQUEST packet containing the appropriate registration-facilities as shown in Table 21-A. The appropriate registration-facilities, as indicated in Table 21-A, are used by the DCE or DTE (DTE/DTE interface) in a REGISTRATION_CONFIRMATION packet to specify a value for each Class 5 optional user facility applicable to the interface.

Registering Values for Class 5.1 (Boolean) Optional User Facilities

The appropriate registration-facilities are used by a DTE in a REGISTRATION_REQUEST packet to specify whether optional user facilities are to be invoked or revoked. (The REGISTRATION_REQUEST packet transmitted across the interface may also contain other registration facilities.)

The appropriate registration-facilities are used by the DCE or DTE in a REGISTRATION_CONFIRMATION packet to specify whether optional user facilities are invoked or revoked.

Registering Values for Class 5.2 (Numeric) Optional User Facilities

The appropriate registration-facilities are used in a REGISTRATION_REQUEST packet to specify the numeric values that the DTE wishes to negotiate for the corresponding Class 5.2 optional user facilities. (The REGISTRATION_REQUEST packet transmitted across the interface may also contain other registration-facilities).

When using the "Logical_Channel_Types_Ranges" Registration-Facility, the values to be negotiated are the parameters (i. e., boundary points) associated with the one-way incoming logical channels (LIC and HIC), two-way logical channels (LTC and HTC), and one-way outgoing logical channels (LOC and HOC) as shown in Appendix A, "Logical Channel Ranges." The relationships between LIC, HIC, LTC, HTC, LOC, and HOC shown in Figure 1 must be maintained. When there are no one-way incoming logical channels, LIC and HIC are equal to zero. When there are no two-way logical channels, LTC and HTC are equal to zero. When there are no one-way outgoing logical channels, LOC and HOC are equal to zero. In addition, the "Logical_Channel_Types_Ranges" Registration-Facility also indicates the total number of logical channels that the DTE wishes to user for virtual calls. This total is equal to the sum of the number of one-way incoming logical channels, two-way logical channels, and one-way outgoing logical channels.

The appropriate registration-facilities are used by the DCE and DTE in a REGISTRATION_CONFIRMATION packet to specify the values of the corresponding Class 5.2 optional user facilities. The relationship between the values of Class 5.2 optional user facilities, if any, in a REGISTRATION_REQUEST packet and those in the REGISTRATION_CONFIRMATION packet is as follows:

- if the requested value is acceptable, then the requested value is shown;
- if the requested value is greater than the maximum-permitted value of that facility, then the value shown is the maximum-permitted value; and
- if the requested value is less than the minimum-permitted value of that facility, then the value shown is the minimum-permitted value.

6.2 Extended Packet Sequence Numbering

Extended_Packet_Sequence_Numbering is an optional user facility agreed upon for a period of time. It is common to all logical channels at the DTE/DCE or DTE/DTE interface.

This user facility, if subscribed to, provides sequence numbering of packets performed modulo '128'. In the absence of this facility, the sequence numbering of packets is performed modulo '8'.

6.3 D Bit Modification

D_Bit_Modification is an optional user facility agreed upon for a period of time. This facility applies to all virtual calls and permanent virtual circuits at the DTE/DCE interface. This facility is only intended for use by those DTEs implemented prior to the introduction of the D-bit procedure which were designed for operation on public data networks that support end-to-end Pr significance. It allows these DTEs to continue to operate with end-to-end Pr significance within a national network.

For communication within the national network, this facility, when subscribed to:

- will change from 0 to 1 the value of bit 7 of the GFI in all CALL_REQUEST and CALL_ACCEPTED packets and the value of the D-bit in all DTE_DATA packets received from the DTE; and,
- will set to '0' the value of bit 7 of the GFI in all INCOMING_CALL and CALL_CONNECTED packets, and the value of the D-bit in all DCE_DATA packets transmitted to the DTE.

For international operation, conversion b) above applies and conversion a) above does not apply. Other conversion rules for international operation are for bilateral agreement between Administrations.

6.4 Packet Retransmission

The Packet_Retransmission facility is not used in SNA environments.

6.5 Incoming Calls Barred

This optional user facility applies only to virtual call service in a DTE/DCE environment.

Incoming_Calls_Barred is an optional user facility agreed upon for a period of time. This facility applies to all logical channels at the DTE/DCE interface used for virtual calls.

This user facility, if subscribed to, prevents incoming virtual calls from being presented to the DTE. The DTE may originate outgoing virtual calls.

Notes:

1. Logical channels used for virtual calls retain their full duplex capability.
2. Some Administrations may provide a capability that also allows a virtual call to be presented to the DTE only in cases where the called address is the address of the calling DTE (i. e., a DTE may place a virtual call to itself even though incoming calls are barred.)

6.6 Outgoing Calls Barred

This optional user facility applies only to virtual call service in a DTE/DCE environment.

Outgoing_Calls_Barred is an optional user facility agreed upon for a period of time. This facility applies to all logical channels at the DTE/DCE interface used for virtual calls.

This user facility, if subscribed to, prevents the DCE from accepting outgoing virtual calls from the DTE. DTEs may receive incoming virtual calls only.

Note:

Logical channels used for virtual calls retain their full duplex capability.

6.7 One-Way Logical Channel Outgoing

One_Way_Logical_Channel_Outgoing is an optional user facility agreed upon for a period of time and is recommended for IBM SNA X.25 DTEs that support multiple virtual circuits. This user facility, if subscribed to, restricts the logical channel use to originating outgoing virtual calls only.

Note:

A logical channel used for virtual calls retains its full duplex capability.

The rules according to which logical channel group numbers and logical channel numbers can be assigned to one-way outgoing logical channels for virtual calls are given in Appendix A, "Logical Channel Ranges."

Note:

If all the logical channels for virtual calls are one-way outgoing at a DTE/DCE or DTE/DTE interface, the effect is equivalent to the Incoming_Calls_Barred facility (except that Note 2 of § 6.5 does not apply).

6.8 One-Way Logical Channel Incoming

One_Way_Logical_Channel_Incoming is an optional user facility agreed upon for a period of time. This user facility, if subscribed to, restricts logical channel use to receiving incoming virtual calls only. This facility is recommended for IBM SNA X.25 DTEs that support multiple virtual circuits.

Note:

A logical channel used for virtual calls retains its full duplex capability.

The rules according to which logical channel group numbers and logical channel numbers can be assigned to one-way incoming logical channels for virtual calls are given in Appendix A, "Logical Channel Ranges."

Note:

If all logical channels for virtual calls are one-way incoming at a DTE/DCE or DTE/DTE interface, the effect is equivalent to the Outgoing_Calls_Barred facility (see § 6.6).

6.9 Non-Standard Default Packet Sizes

Non_Standard_Default_Packet_Sizes is an optional user facility agreed upon for a period of time. The ability to select this facility must be provided by IBM SNA X.25 DTEs. This facility, if subscribed to, provides for the selection of default packet sizes from the list of packet sizes supported by the Administration. Some networks may constrain packet sizes to be the same for each direction of data transmission across the DTE/DCE or DTE/DTE interface. The default packet size used by a DTE should always be capable of being set to 128. In the absence of this facility, default packet sizes are '128' octets.

Note:

In this section, the term "packet sizes" refers to the maximum User_Data field lengths of DCE_DATA and DTE_DATA packets.

Values other than the default packet sizes may be negotiated for a virtual call, on a per call basis, by means of the flow control parameter negotiation facility (see § 6.12), which may be implemented in IBM SNA X.25 DTEs. Values other than the default packet sizes may be agreed for a period of time for each permanent virtual circuit.

6.10 Non-Standard Default Window Sizes

Non-Standard_Default_Window_Sizes is an optional user facility agreed upon for a period of time. The ability to select this facility must be provided by IBM SNA X.25 DTEs. This user facility, if subscribed to, provides for the selection of default window sizes from the list of window sizes supported by the Administration. Some networks may constrain the default window sizes to be the same for each direction of data transmission across the DTE/DCE or DTE/DTE interface. The default window size used by a DTE should always be capable of being set to 2. In the absence of this facility, the default window sizes are two (2).

Values other than the default window sizes may be negotiated for virtual calls, on a per call basis, by means of the Flow Control Parameter Negotiation facility (see § 6.12), which is recommended for implementation by IBM SNA X.25 DTEs. Values other than the default window sizes may be agreed upon for a period of time for each permanent virtual circuit.

6.11 Default Throughput Classes Assignment

Default Throughput Classes Assignment is an optional user facility agreed upon for a period of time. This user facility, if subscribed to, provides for the selection of default throughput classes from the list of throughput classes supported by the Administration. Some networks may constrain the default throughput classes to be the same for each direction of data transmission. In the absence of this facility, the default throughput classes correspond to the user class of service of the DTE (see § 7.2.2.2). In a DTE/DCE environment, they may not exceed the maximum throughput class supported by the network.

The default throughput classes are the maximum throughput classes which may be associated with any virtual call at the DTE/DCE or DTE/DTE interface. Values other than the default throughput classes may be negotiated for a virtual call by means of the Throughput Class Negotiation facility (see § 6.13). Values other than the default throughput classes may be agreed upon for a period of time for each permanent virtual circuit.

Note:

> Throughput characteristics and throughput class are described in Section 4.4.2.

6.12 Flow_Control_Parameter_Negotiation

This optional user facility applies only to virtual call service.

Flow_Control_Parameter_Negotiation is an optional user facility agreed upon for a period of time which can be used by a DTE for virtual calls. The ability for the DTE to select this facility is recommended for IBM SNA X.25 DTEs. This facility, if subscribed to, permits negotiation, on a per call basis, of flow control parameters. The flow control parameters considered are the packet and window sizes at the DTE/DCE or DTE/DTE interface for each direction of data transmission.

Note:

> In this section, the term "packet sizes" refers to the maximum User_Data field lengths of DCE_DATA and DTE_DATA packets.

In the absence of the Flow_Control_Parameter_Negotiation facility, the flow control parameters to be used at a particular DTE/DCE interface are the default packet sizes (see § 6.9) and the default window sizes (see § 6.10).

When the calling DTE has subscribed to the Flow_Control_Parameter_Negotiation facility, it may separately request, in the CALL_REQUEST packet, packet sizes and/or window sizes for both directions of data transmission (see §§ 7.2.1 and 7.2.2.1). If particular window sizes are not explicitly requested in a CALL_REQUEST packet, the DCE (or DTE for DTE/DTE) will assume that the default window sizes were requested for both directions of data transmission. If particular packet sizes are not explicitly requested, the DCE (or DTE for DTE/DTE) will assume that the default packet sizes were requested for both directions of data transmission.

When a called DTE has subscribed to the Flow_Control_Parameter_Negotiation facility, each INCOMING_CALL packet indicates the packet and window sizes from which negotiation can start (in a DTE/DTE environment, such an indication is present only if the calling DTE has provided it in its CALL_REQUEST packet). No relationship needs to exist between the packet sizes (P) and window sizes (W) requested in the CALL_REQUEST packet and those indicated in the INCOMING_CALL packet (except in a DTE/DTE environment where the CALL_REQUEST and INCOMING_CALL packets are really the same packet). The called DTE may request window and packet sizes with facilities in the CALL_ACCEPTED packet. The only valid facility requests in the CALL_ACCEPTED packet, as a function of the facility indications in the INCOMING_CALL packet, are given in Table 22. If the facility request is not made in the CALL_ACCEPTED packet, the DTE is assumed to have accepted the indicated values (regardless of the default values) for both directions of data transmission. In a DTE/DTE environment, if no facility indication was present in the INCOMING_CALL packet and no facility request is made in the CALL_ACCEPTED packet, then the called DTE is assumed to have accepted the default values.

Table 22: Valid facility requests in CALL_ACCEPTED packets in response to facility indications in INCOMING_CALL packets

Facility Indication	Valid Facility Request
W (indicated) ≥ 2	W (indicated) ≥ W (requested) ≥ 2
W (indicated) = 1	W (requested) = 1 or 2
P (indicated) ≥ 128	P (indicated) ≥ P (requested) ≥ 128
P (indicated) < 128	128 ≥ P (requested) ≥ P (indicated)

In a DTE/DCE environment, when the calling DTE has subscribed to the Flow_Control_Parameter_Negotiation facility, every CALL_CONNECTED packet indicates the packet and window sizes to be used at the DTE/DCE interface for the call. In a DTE/DTE environment, absence of a facility indication in the CALL_CONNECTED packet indicates that the called DTE has accepted the values in the INCOMING_CALL packet or, if none, the default values. The only valid facility indications in the CALL_CONNECTED packet, as a function of the facility requests in the CALL_REQUEST packet, are given in Table 23.

Table 23: Valid facility indications in CALL_CONNECTED packets in response to facility request in CALL_REQUEST packets

Facility Request	Valid Facility Indication
W (requested) ≥ 2	W (requested) ≥ W (indicated) ≥ 2
W (requested) = 1	W (indicated) = 1 or 2
P (requested) ≥ 128	P (requested) ≥ P (indicated) ≥ 128
P (requested) < 128	128 ≥ P (indicated) ≥ P (requested)

The network may have constraints requiring the flow control parameters used for a call to be modified before indicating them to the DTE in the INCOMING_CALL packet or CALL_CONNECTED packet; e.g., the ranges of parameter values available on various networks may differ.

Window and packet sizes need not be the same at each end of a virtual call.

The role of the DCE in negotiating the flow control parameters may be network dependent.

6.13 Throughput Class Negotiation

This optional user facility applies only to virtual call service.

Throughput_Class_Negotiation is an optional user facility agreed upon for a period of time which can be used by a DTE for virtual calls. This facility, if subscribed to, permits negotiation, on a per call basis, of the throughput classes; and, should be supported by IBM SNA X.25 DTEs that support multiple virtual circuits. The throughput classes are considered independently for each direction of data transmission.

In a DTE/DCE environment, default values are agreed between the DTE and the Administration (see § 6.11). The default values correspond to the maximum throughput classes which may be associated with any virtual call at the DTE/DCE interface.

When the calling DTE has subscribed to the Throughput_Class_Negotiation facility, it may request the throughput classes of the virtual call in the CALL_REQUEST packet for both directions of data transmission (see §§ 7.2.1 and 7.2.2.2). If particular throughput classes are not explicitly requested, the DCE will assume that the default values were requested for both directions of data transmission.

When a called DTE has subscribed to the Throughput_Class_Negotiation facility, each INCOMING_CALL packet will indicate the throughput classes from which DTE negotiation may start (in a DTE/DTE environment, such an indication is present only if the calling DTE has provided it in its CALL_REQUEST packet). These throughput classes are lower or equal to the ones selected by the calling DTE, either explicitly or by default if the calling DTE has not subscribed to the Throughput_Class_Negotiation facility or has not explicitly requested throughput class values in the CALL_REQUEST packet. In a DTE/DTE environment, the called DTE should assume that the default throughput classes were requested if no indication is present in the INCOMING_CALL packet. In a DTE/DCE environment, the throughput classes indicated to the called DTE will also not be higher than the default throughput classes, respectively, for each direction of transmission, at the calling and the called DTE/DCE interfaces. They may be further constrained by internal limitations of the network.

The called DTE may request with a facility in the CALL_ACCEPTED packet the throughput classes that should finally apply to the virtual call. The only valid throughput classes in the CALL_ACCEPTED packet are lower than or equal to the ones (respectively) indicated in the INCOMING_CALL packet. If the called DTE does not make any throughput class facility request in the CALL_ACCEPTED packet, the throughput classes finally applying to the virtual call will be the ones indicated in the INCOMING_CALL packet.

In a DTE/DCE environment, if the called DTE has not subscribed to the Throughput_Class_Negotiation facility, the throughput classes finally applying to the virtual call are less than or equal to the ones selected at the calling DTE/DCE interface, and less than or equal to the default values defined at the called DTE/DCE interface.

When the calling DTE has subscribed to the Throughput_Class_Negotiation facility, every CALL_CONNECTED packet will indicate the throughput classes finally applying to the virtual call. In a DTE/DTE environment, such an indication is present only if the called DTE has provided it in its CALL_ACCEPTED packet; in its absence, the calling DTE should assume the throughput classed requested in its CALL_REQUEST packet or, if none, the default throughput classes apply.

In a DTE/DCE environment, when neither the calling DTE nor the called DTE has subscribed to the Throughput_Class_Negotiation facility, the throughput classes applying to the virtual call will not be higher than the ones agreed as defaults at the calling and called DTE/DCE interfaces. They may be further constrained to lower values by the network, e.g., for international service.

Notes:

1. Since both Throughput_Class_Negotiation and Flow_Control_Parameter_Negotiation (see § 6.12) facilities can be applied to a single call, the achievable throughput will depend on how users manipulate the 'D' bit.
2. Users are cautioned that the choice of too small a window and packet size at a DTE/DCE or DTE/DTE interface (made by use of the Flow_Control_Parameter_Negotiation facility) may adversely affect the attainable throughput class for a virtual call. This is likewise true of flow control mechanisms adopted by the DTE to control data transmission from the DCE (or DTE if DTE/DTE).

6.14 Closed_User_Group Related Facilities

The optional user facilities in this section apply only to virtual call service in a DTE/DCE environment. The set of closed user group (CUG) optional user facilities enables users to form groups of DTEs to and/or from which access is restricted. Different combinations of access restrictions to and/or from DTEs having one or more of these facilities result in various combinations of accessibility.

A DTE may belong to one or more CUGs. Each DTE belonging to at least one CUG has either:

- the Closed_User_Group facility (see § 6.14.1) or
- one or both of:
  - the Closed_User_Group_with_Outgoing_Access, and/or
  - the Closed_User_Group_with_Incoming_Access facilities

  (see §§ 6.14.2 and 6.14.3).

For each CUG to which a DTE belongs, either or none of:

- the Incoming_Calls_Barred_within_a_Closed_User_Group; or

- the Outgoing_Calls_Barred_within_a_Closed_User_Group facilities. (see §§ 6.14.4 and 6.14.5) may apply for that DTE. Different combinations of CUG facilities may apply for different DTEs belonging to the same CUG.

Depending on the CUG-related subscriptions and the number of CUGs that the DTE belongs to, a preferential CUG may also be required to be specified by the DTE. Specification of a preferential CUG allows a CUG to be designated for a given virtual call without explicitly indicating it in a CALL_REQUEST or INCOMING_CALL packet.

When a DTE belonging to one or more CUGs places a virtual call, the DTE may explicitly indicate in the CALL_REQUEST packet the CUG selected by using:

- the Closed_User_Group_Selection facility (see § 6.14.6): or
- the Closed_User_Group_with_Outgoing_Access_Selection facility (see § 6.14.7) (see Note). When a DTE belonging to one or more CUGs receives a virtual call, the CUG selected may be explicitly indicated in the INCOMING_CALL packet through the use of the Closed_User_Group_Selection facility or the Closed_User_Group_with_Outgoing_Access_Selection facility.

Note:

For a given virtual call, only one of the above mentioned selection facilities can be present.

The number of CUGs to which a DTE can belong is network dependent.

6.14.1 Closed_User_Group

This optional user facility applies only to virtual call service in a DTE/DCE environment.

Closed_User_Group is an optional user facility agreed upon for a period of time for virtual calls. This user facility, if subscribed to, enables the DTE to belong to one or more closed user groups. A closed user group permits the DTEs belonging to the group to communicate with each other, but precludes communication with all other DTEs.

When the DTE belongs to more than one closed user group, a preferential closed user group must be specified.

When the Closed_User_Group facility is subscribed to, then only the Closed_User_Group_Selection facility is applicable for use at the DTE/DCE interface.

IBM SNA X.25 DTEs that support a single closed user group require no coding in the facilities field when the PSDN supports the assignment of a default user group.

6.14.2 Closed_User_Group_with_Outgoing_Access

This optional user facility applies only to virtual call service in a DTE/DCE environment.

Closed_User_Group_with_Outgoing_Access is an optional user facility agreed upon for a period of time for virtual calls. This user facility, if subscribed to, enables the DTE to belong to one or more closed user groups (as in § 6.14.1) and to originate virtual calls to DTEs in the open part of the network (i.e., DTEs not belonging to any closed user group) and to DTEs belonging to other CUGs with the incoming access capability.

When the Closed_User_Group_with_Outgoing_Access facility is subscribed to and the DTE has a preferential CUG, then only the Closed_User_Group_Selection facility (as in § 6.14.6) is applicable for use at the interface.

When the Closed_User_Group_with_Outgoing_Access facility is subscribed to and the network offers to the DTE the capability of choosing whether or not to have a preferential CUG (i.e., the Closed_User_Group_with_Outgoing_Access_Selection facility, (see § 6.14.7) is offered by the network), and the DTE has no preferential CUG, then both the Closed_User_Group_Selection and the Closed_User_Group_with_Outgoing_Access_Selection facilities are applicable for use at the interface. In all other cases of subscription to the Closed_User_Group_With_Outgoing_Access facility, the DTE must specify a preferential CUG and only the Closed_User_Group_Selection facility is applicable for use at the interface.

6.14.3 Closed_User_Group_with_Incoming_Access

This optional user facility applies only to virtual call service in a DTE/DCE environment.

Closed_User_Group_with_Incoming_Access is an optional user facility agreed upon for a period of time for virtual calls. This user facility, if subscribed to, enables the DTE to belong to one or more closed user groups (as in § 6.14.1) and to receive incoming calls from DTEs in the open part of the network (i.e, DTEs not belonging to any closed user group) and from DTEs belonging to other CUGs with the outgoing access capability.

When the Closed_User_Group_with_Incoming_Access facility is subscribed to and the DTE has a preferential CUG, then only the Closed_User_Group_Selection facility is applicable for use at the interface.

When the Closed_User_Group_with_Incoming_Access facility is subscribed to and the network offers to the DTE the capability of choosing whether or not to have a preferential CUG (i.e., the Closed_User_Group_with_Outgoing_Access facility is offered by the network), and the DTE has no preferential CUG, then both the Closed_User_Group_Selection and the Closed_User_Group_with_Outgoing_Access_Selection facilities are applicable for use at the interface.

6.14.4 Incoming_Calls_Barred_within_a_Closed_User_Group

This optional user facility applies only to virtual call service in a DTE/DCE environment.

Incoming_Calls_Barred_within_a_Closed_User_Group is an optional user facility agreed upon for a period of time. This user facility, if subscribed to for a given closed user group, permits the DTE to originate virtual calls to DTEs in this closed user group, but precludes the reception of incoming calls from other DTEs in this closed user group.

6.14.5 Outgoing_Calls_Barred_within_a_Closed User Group

This optional user facility applies only to virtual call service in a DTE/DCE environment.

Outgoing_Calls_Barred_within_a_Closed_User_Group is an optional facility agreed upon for a period of time. This user facility, if subscribed to for a given closed user group, permits the DTE to receive virtual calls from DTEs in this closed user group, but prevents the DTE from originating virtual calls to DTEs in this closed user group.

6.14.6 Closed_User_Group_Selection

This optional user facility applies only to virtual call service in a DTE/DCE environment.

Closed_User_Group_Selection is an optional user facility which may be used on a per virtual call basis. This facility may be requested or received by a DTE only if it has subscribed to the Closed_User_Group facility, or the Closed_User_Group_with_Outgoing_Access facility and/or the Closed_User_Group_with_Incoming_Access facility.

The Closed_User_Group_Selection facility (see §§ 7.2.1 and 7.2.2.3) may be used by the calling DTE in the CALL_REQUEST packet to specify the closed user group selected for a virtual call.

The Closed_User_Group_Selection facility is used in the INCOMING_CALL packet to indicate to the called DTE the closed user group selected for a virtual call.

The number of closed user groups to which a DTE can belong is network dependent. If the maximum value of the index used by the DTE to select the closed user group is 99 or less, the basic format of the Closed_User_Group_Selection facility must be used. If the value of the index is between 100 and 9999, the extended format of the Closed_User_Group_Selection facility must be used.

Some networks may permit a DTE to use either the basic or extended format of the Closed_User_Group_Selection facility when the index is 99 or less.

Note:

When a DTE subscribes to less than 101 closed user groups, the network should be able to agree on a maximum value of the index smaller than 100 if requested by the DTE.

The appearance in a CALL_REQUEST packet of both formats or a format inconsistent with the number of CUGs subscribed to will be treated as an error for which the network clears the call with a cause indicating "Invalid Facility Request."

The significance of the Closed_User_Group_Selection facility:

- in CALL_REQUEST packets is given in Table 24; and
- in INCOMING_CALL packets is given in Table 25.

6.14.7 Closed_User_Group_with_Outgoing_Access_Selection

This optional user facility applies only to virtual call service in a DTE/DCE environment.

Closed_User_Group_with_Outgoing_Access_Selection is an optional user facility which may be used on a per virtual call basis. This facility may be requested by a DTE only if the network supports it and

- the DTE has subscribed to the Closed_User_Group_with_Outgoing_Access facility or to both the
  - Closed_User_Group_with_Outgoing_Access and
  - Closed_User_Group_with_Incoming_Access facilities.

This facility may be received by a DTE only if the network supports it and the DTE has subscribed to the Closed_User_Group_with_Incoming_Access facility or to both the Closed_User_Group_with_Incoming_Access and Closed_User_Group_with_Outgoing_Access facilities.

The Closed_User_Group_with_Outgoing_Access_Selection facility (see §§ 7.2.1 and 7.2.2.4) may be used by the calling DTE in the CALL_REQUEST packet to specify the closed user group selected for a virtual call and to indicate that outgoing access is also desired.

The Closed_User_Group_with_Outgoing_Access_Selection facility is used in the INCOMING_CALL packet to indicate to the called DTE the closed user group selected for a virtual call and that outgoing access had applied at the calling DTE.

The Closed_User_Group_with_Outgoing_Access_Selection facility can only be present in the facility field of CALL_SET-UP packets if the DTE does not have a preferential closed user group.

The number of closed user groups to which a DTE can belong is network dependent. If the maximum value of the index used by the DTE to select the closed user group is 99 or less, the basic format of the Closed_User_Group_With_Outgoing_Access_Selection facility must be used. If the value of the index is between 100 and 9999, the extended format of the Closed_User_Group_With_Outgoing_Access_Selection facility must be used.

Some networks may permit a DTE to use either the basic or extended format of the Closed_User_Group_With_Outgoing_Access_Selection facility when the index is 99 or less.

Note:

When a DTE subscribes to less than 101 closed user groups, the network should be able to agree on a maximum value of the index smaller than 100 if requested by the DTE.

The appearance in a CALL_REQUEST packet of both formats or a format inconsistent with the number of CUGs subscribed to will be treated as an error for which the network clears the call with a cause indicating "Invalid Facility Request."

The significance of the presence of the Closed_User_Group_with_Outgoing_Access_Selection facility;

- in CALL_REQUEST packets is given in Table 24 and in
- in INCOMING_CALL packets is given in Table 25.

6.14.8 Absence of Both CUG Selection Facilities

The significance of the absence of both the CUG_Selection facility and the CUG_with_Outgoing_Access_Selection facility:

- in CALL_REQUEST packets is given in Table 24 and
- in INCOMING_CALL packets is given in Table 25.

Table 24: Meaning of Closed User Group Facility in CALL_REQUEST Packets

Calling DTE CUG Subscription (1) \ CALL_REQUEST Packet Contents (2)	CUG Selection Facility	CUG with OA Selection Facility	Neither CUG Selection Facility
CUG w/Preferential CUG (3)	CUG Specified (4)	NA (Call CLeared)	Preferental or Only CUG (Note 4)
CUG/IA w/Preferential CUG			
CUG/OA w/Preferential CUG	CUG Specified Plus OA (4)		Preferential or Only CUG plus OA (5 & 6)
CUG/IA/OA w/Preferential CUG			
CUG/IA w/o Preferential CUG	CUG		NA (Call Cleared)
CUG/OA w/o Preferential CUG	CUG Specified (4)	CUG Specified Plus OA (5 & 6)	Outgoing Access
CUG/IA/OA w/o Preferential CUG			
No CUG	NA (Call Cleared)	NA (Call Cleared)	

(#) Refer to Notes Below CUG: Closed User Group IA: Incoming Access OA: Outgoing Access

Notes with reference to Table 24::

1. The order of subscription types is different than Table 25.
2. The inclusion of both the Closed_User_Group_Selection facility and the Closed_User_Group_with_Outgoing_Access_Selection facility is not allowed in the CALL_REQUEST packet.
3. CUG without preferential CUG is not allowed.
4. If outgoing calls are barred within the specified CUG or within the preferential or only CUG, then the call is cleared.
5. If outgoing calls are barred within the specified CUG or within the preferential or only CUG, then only Outgoing_Access applies.
6. For international calls, if the destination network does not support the Closed_User_Group_with_Outgoing_Access_Selection facility, the call may be cleared even if the called DTE belongs to the specified closed user group or to the open world or has incoming access.

<table>
<tr><th colspan="4">Table 25: Meaning of Closed User Group Facility in INCOMING_CALL Packets</th></tr>
<tr><th>Calling \INCOMING_CALL Packet
DTE CUG \ Contents
Subscription (1) \</th><th>CUG Selection Facility</th><th>CUG with OA Selection Facility</th><th>Neither CUG Selection Facility</th></tr>
<tr><td>CUG with Preferential CUG (2)</td><td rowspan="2">CUG Specified (3)</td><td rowspan="5">Not Applicable</td><td rowspan="2">Preferential or Only CUG (3)</td></tr>
<tr><td>CUG/OA w/Preferential CUG</td></tr>
<tr><td>CUG/IA w/Preferentail CUG</td><td rowspan="2">CUG Specified Plus IA (4)</td><td rowspan="2">Preferential or Only CUG Plus IA (5)</td></tr>
<tr><td>CUG/IA/OA w/Preferential CUG</td></tr>
<tr><td>CUG/OA w/o Preferential CUG</td><td rowspan="3">CUG Specified (3)</td><td>Not Applicable</td></tr>
<tr><td>CUG/IA w/o Preferential CUG</td><td rowspan="2">CUG Specified Plus IA (4)</td><td rowspan="3">Incoming Access</td></tr>
<tr><td>CUG/IA/OA w/o Preferential CUG</td></tr>
<tr><td>No CUG</td><td>Not Applicable</td><td>Not Applicable</td></tr>
<tr><td colspan="4">(#) Refer to Notes Below CUG: Closed User Group IA: Incoming Access OA: Outgoing Access</td></tr>
</table>

Notes with reference to Table 25::

1. The order of subscription types is different than Table 24.
2. CUG without preferential is not allowed.
3. When incoming calls are barred within this CUG, the call is blocked; there is no incoming call.
4. When incoming calls are barred within this CUG, only incoming access applies and the INCOMING_CALL packet carries neither

the Closed_User_Group_Selection nor the Closed_User_Group_with_Outgoing_Access_Selection facility.

5. When incoming calls are barred within this CUG, only incoming access applies.

6.15 Bilateral_Closed_User_Group Related Facilities

The optional user facilities in this section apply only to virtual call service in a DTE/DCE environment.

The set of bilateral closed user group (BCUG) optional user facilities enables pairs of DTEs to form bilateral relations allowing access between each other while excluding access to or from other DTEs with which such a relation has not been formed. Different combinations of access restrictions for DTEs having these facilities result in various combinations of accessibility.

There are three BCUG-related facilities: two of these are facilities that each DTE and the network agree to for a period of time; the other facility permits the BCUG selected for a given virtual call to be indicated. The three facilities are:

1) Bilateral_Closed_User_Group: this is the basic facility that enables a DTE to belong to one or more BCUGs;

2) Bilateral_Closed_User_Group_With_Outgoing_Access: this is a variant of (a) that also enables the DTE to make outgoing calls to DTEs in the open part of the network (i. e., to DTEs not belonging to any BCUG); and

3) Bilateral_Closed_User_Group_Selection: this facility provides for the specification of the BCUG pertaining to a specific virtual call.

A DTE may belong to one or more BCUGs. Each DTE belonging to at least one BCUG has either the BCUG facility (see § 6.15.1) or the BCUG_with_Outgoing_Access facility (see § 6.15.2). For a given BCUG, it is permissible for one DTE to subscribe to the BCUG facility while the other DTE subscribes to the BCUG_with_Outgoing_Access facility.

When a DTE belonging to one or more BCUGs places a virtual call, the DTE should indicate in the CALL_REQUEST packet the BCUG selected by using the BCUG_Selection facility (see § 6.15.3). When a DTE belonging to one or more BCUGs receives a virtual call, the BCUG selected will be indicated in the INCOMING_CALL packet through the use of the BCUG_Selection facility.

The number of BCUGs to which a DTE can belong is network dependent.

A DTE may, at the same time, have one of the facilities described in this section and one or more of the Closed_User_Group related facilities described in Section 6.16. The CUG and BCUG facilities are independent of one another. For example, a call within a CUG is not regarded as an outgoing access call in relation to the BCUG-related facilities.

6.15.1 Bilateral_Closed_User_Group

Bilateral_Closed_User_Groups are not allowed in SNA environments.

6.15.2 Bilateral_Closed_User_Group_with_Outgoing_Access

Bilateral_Closed_User_Groups_with_Outgoing_Access are not allowed in SNA environments.

6.15.3 Bilateral_Closed_User_Group_Selection

Bilateral_Closed_User_Groups and, thus, BCUG_Selection are not allowed in SNA environments.

6.16 Fast_Select

This optional user facility applies only to virtual call service.

6.16.1 SNA-to-SNA Connections

The possible use of the Fast_Select facility on SNA-to-SNA connections is a subject for further study.

6.16.2 SNA-to-non_SNA Connections

Fast_Select is an optional user facility which may be requested by a DTE for a given virtual call. In a DTE/DCE environment, a DTE may use this facility without prior agreement. In a DTE/DTE environment, prior agreement between the two DTEs is required to use this facility. Such an agreement permits both DTEs to originate calls with this facility and requires them to process received calls using this facility.

If, in a DTE/DCE environment, a DTE places a call using Fast_Select to a DTE that has not subscribed to the Fast_Select_Acceptance Facility, then the call will be cleared by the network with a cause indicating "Fast Select Acceptance Not Subscribed." If, in a DTE/DTE environment, a DTE places a call to a DTE that did not agree to use Fast_Select, then the called DTE may clear the call with a cause indicating "DTE Originated" and the diagnostic "Fast_Select_Not_Subscribed."

DTEs can request the Fast_Select facility on a per call basis by means of an appropriate facility request (see §§ 7.2.1 and 7.2.2.10) in a CALL_REQUEST packet using any logical channel which can be used for originating virtual calls.

The Fast_Select facility, if requested in the CALL_REQUEST packet and if it indicates no restriction on response:

- allows this packet to contain a Call_User_Data field of up to '128' octets,
- authorizes the DCE (or DTE if DTE/DTE) to transmit to the calling DTE, during the DTE_Waiting state, a
  - CALL_CONNECTED packet with a Called_User_Data field, or
  - a CLEAR_INDICATION packet with a Clear_User_Data field,

  of up to 128 octets, and
- authorizes the calling DTE and the DCE (or DTE if DTE/DTE) to transmit after the call is connected,

– a CLEAR_REQUEST packet or
– a CLEAR_INDICATION packet,

respectively, with a Clear_User_Data field of up to '128' octets.

The Fast_Select facility, if requested in the CALL_REQUEST packet and if it indicates restriction on response:

- allows this packet to contain a call user data field of up to 128 octets; and
- authorizes the DCE (or DTE if DTE/DTE) to transmit to the calling DTE, during the DTE_Waiting state, a clear indication packet with a clear user data field of up to 128 octets; the DCE would not be authorized to transmit a CALL_CONNECTED packet.

When a DTE requests the fast select facility in a CALL_REQUEST packet, the INCOMING_CALL packet should only be delivered to the called DTE if that DTE has subscribed to the Fast_Select_Acceptance facility (see 6.17).

If the called DTE has subscribed to the Fast_Select_Acceptance facility, it will be advised that the Fast_Select_Facility, and an indication of whether or not there is a restriction on the response, has been requested through the inclusion of the appropriate facility (see §§ 7.2.1 and 7.2.2.6) in the INCOMING_CALL packet.

If the called DTE has not subscribed to the Fast_Select_Acceptance facility, an INCOMING_CALL packet with the Fast_Select facility requested will not be transmitted and a CLEAR_INDICATION packet with the cause "Fast_Select_Acceptance_Not_Subscribed" will be returned to the calling DTE.

The presence of the Fast_Select facility indicating no restriction on response in an INCOMING_CALL packet permits the DTE to issue, as a direct response to this packet, a CALL_ACCEPTED packet with a Called_User_Data field of up to '128' octets or a CLEAR_REQUEST packet with a Clear_User_Data field of up to '128' octets. If the call is connected, the DTE and the DCE are then authorized to transmit a CLEAR_REQUEST or a CLEAR_INDICATION packet, respectively, with a Clear_User_Data field of up to '128' octets.

The presence of the Fast_Select facility indicating restriction on response in an INCOMING_CALL packet permits the DTE to issue, as a direct response to this packet, a CLEAR_REQUEST packet with a Clear_User_Data field of up to '128' octets; the DTE would not be authorized to send a CALL_ACCEPTED packet.

Note:

The Call_User_Data field, the Called_User_Data field and the Clear_User_Data field will not be fragmented for delivery across the interface.

The significance of the CALL_CONNECTED packet and the CLEAR_INDICATION packet with the cause "DTE originated" as a direct response to the CALL_REQUEST packet with the Fast_Select facility is that the CALL_REQUEST packet with the data field has been received by the called DTE.

All other procedures of a call in which the Fast_Select facility has been requested are the same as those of a virtual call.

6.17 Fast_Select_Acceptance

This optional user facility applies only to virtual call service in a DTE/DTE environment.

6.17.1 SNA-to-SNA Connections

The possible use of the Fast_Select_Acceptance facility in SNA environments is a subject for further study.

6.17.2 SNA-to-non SNA Connections

Fast_Select_Acceptance is an optional user facility agreed upon for a period of time. This user facility, if subscribed to, authorizes the DCE to transmit to the DTE INCOMING_CALL packets which request the Fast_Select facility. In the absence of this facility, the DCE will not transmit to the DTE INCOMING_CALL packets which request the Fast_Select facility.

If the called DTE has subscribed to the Fast_Select_Acceptance Facility, it will be advised that Fast Select, as well as an indication of whether there is a restriction on the response, has been requested through the inclusion of the Fast Select Facility in the INCOMING_CALL packet.

The presence of the Fast_Select Facility indicating no restriction on response in an INCOMING_CALL packet permits the called DTE:

- to issue, as a direct response to this packet, a CALL_ACCEPTED packet with a Called_User_Data Field of up to 128 octets;
- to issue, at any time, a CLEAR_REQUEST packet with a Clear_User_Data Field of up to 128 octets; and
- to receive, after call setup has been completed, a CLEAR INDICATION packet with a Clear_User_Data Field of up to 128 octets.

The presence of the Fast_Select Facility indicating restriction on response in an INCOMING_CALL packet permits the called DTE to issue, as a direct response to this packet, a CLEAR_REQUEST packet with a Clear_User_Data Field of up to 128 octets; the called DTE is not authorized to send a CALL_ACCEPTED packet.

Note:

The Call_User_Data field, Called_User_Data field and Clear_User_Data field will not be fragmented for delivery across the interface.

6.18 Reverse Charging

This optional user facility applies only to virtual call service in a DTE/DCE environment.

Reverse_Charging is an optional user facility which can be requested by a DTE for a given virtual call (see §§ 7.2.1 and 7.2.2.6) to request that charges for the call be made against the called DTE. This facility is recommended for IBM SNA X.25 DTEs.

6.19 Reverse_Charging_Acceptance

This optional user facility applies only to virtual call service in a DTE/DCE environment.

Reverse_Charging_Acceptance is an optional user facility agreed upon for a period of time for virtual calls. This user facility, if subscribed to, authorizes the DCE to transmit to the DTE INCOMING_CALL packets which request the Reverse_Charging facility. In the absence of this facility, the DCE will not transmit to the DTE INCOMING_CALL packets which request the Reverse_Charging facility. This facility is recommended for IBM SNA X.25 DTEs.

Note:

Not subscribing to this facility does not necessarily mean that the DCE will not transmit the Reverse_Charging facility with the reverse charging not requested parameter to the DTE.

6.20 Local_Charging_Prevention

This optional user facility applies only to virtual call service in a DTE/DCE environment.

Local_Charging_Prevention is an optional user facility agreed upon for a period of time for virtual calls. This user facility, when subscribed to, authorizes the DCE to prevent the establishment of virtual calls which the subscriber must pay for by:

- not transmitting to the DTE incoming calls which request the Reverse_Charging facility, and
- insuring that the charges are made to another party whenever a call is requested by the DTE. This other party can be determined by using any of a number of actions, both procedural and administrative. Procedural methods include:
    - the use of Reverse_Charging,
    - identification of a third party using the NUI_Subscription facility (see § 6.21).

When the party to be charged has not been established for a call request, the DCE that receives the CALL_REQUEST packet will apply reverse charging to the call.

6.21 Network_User_Identification (NUI) Related Facilities

The optional user facilities in this section apply only to virtual call service in a DTE/DCE environment.

The set of Network_User_Identification (NUI) related facilities enables the DTE to provide information to the network for purposes of billing, security, network management, or to invoke subscribed facilities.

This set is composed of three optional user facilities. NUI_Subscription facility (see § 6.21.1) and NUI_Override facility (see § 6.21.2) may be agreed upon for a period of time for virtual calls. A DTE may subscribe to one or both of these facilities. When one or both of these facilities are subscribed to, one (or several) network user identifier is also agreed upon for a period of time. A given network user identifier may be either specific or common to NUI_Subscription facility and NUI_Override facility. The network user identifier is transmitted by the DTE to the DCE in the NUI_Selection facility (see § 6.21.3).

Network user identifier is never transmitted to the remote DTE. The calling DTE address transmitted to the remote DTE in the calling DTE address field should not be inferred from the network user identifier transmitted by the DTE in the NUI_Selection facility in the CALL_REQUEST packet.

6.21.1 NUI_Subscription

This optional user facility applies only to virtual call service in a DTE/DCE environment.

NUI_Subscription is an optional user facility agreed upon for a period of time for virtual calls. This facility, if subscribed to, enables the DTE to provide information to the network for billing, security or network management purposes on a per call basis. This information is provided by the DTE in the CALL_REQUEST packet or in the CALL_ACCEPTED packet by using the NUI_Selection facility (see § 6.21.3). It may be used whether or not the DTE has also subscribed to the Local_Charging_Prevention facility (see § 6.20). If the DCE determines that the network user identifier is invalid or that the NUI_Selection facility is not present when required by the network, it will clear the call as described in Appendix C, "Packet Layer DCE Actions."

6.21.2 NUI_Override

This optional user facility applies only to virtual call service in a DTE/DCE environment.

NUI_Override is an optional user facility agreed upon for a period of time for virtual calls. When this facility is subscribed to, one or more network user identifiers are also agreed upon for a period of time. Associated with each network user identifier, is a set of subscription-time optional user facilities. When one of these network user identifiers is provided in a CALL_REQUEST packet by means of the NUI_Selection facility (see § 6.21.3), the set of subscription-time optional user facilities associated with it overrides the facilities which apply to the interface. This override does not apply to other existing calls or subsequent calls on the interface. It remains in effect for the duration of the particular call to which it applies.

The optional user facilities that may be associated with a network user identifier when the NUI_Override facility has been subscribed to are specified in Table 25a. The optional user facilities which have been agreed upon for a period of time for the interface and which are not overridden by using the NUI_Override facility remain in effect.

Table 25a: Subscription-time Optional User Facilities that may be associated with a Network User Identifier in Conjunction with the NUI Override Facility	May be associated with a NUI override
On-line facility registration	No
Extended packet sequence numbering	No
D bit modification	No
Packet retransmission	No
Incoming calls barred	No
Outgoing calls barred	No
One-way logical channel outgoing	No
One-way logical channel incoming	No
Non-standard default packet sizes	Yes
Non-standard default window sizes	Yes
Default throughput classes assignment	Yes
Flow control parameter negotiation (subscription time)	Yes
Throughput class negotiation (subscription time)	Yes
Closed user group related facilities	
Closed user group	Yes
Closed user group with outgoing access	Yes
Closed user group with incoming access	No
Incoming calls barred within a closed user group	No
Outgoing calls barred within a closed user group	No
Bilateral closed user group related facilities	
Bilateral closed user group	Yes
Bilateral closed user group with outgoing access	Yes
Fast select acceptance	No
Reverse charging acceptance	No
Local charging prevention	No
Charging information (subscription time)	Yes
RPOA Selection	Yes
Hunt group	No
Call redirection and call deflection related facilities	
Call redirection	No
Call deflection subscription	No
TOA/NPI address subscription	No

6.21.3 NUI_Selection

This optional user facility applies only to virtual call service in a DTE/DCE environment.

NUI_Selection is an optional user facility which may be requested by a DTE for a given virtual call (see §§ 7.2.1 and 7.2.2.7). This user facility may be requested by a DTE only if it has subscribed to the NUI_Subscription facility (see § 6.21.1.) or the NUI_Override facility or both facilities. NUI_Selection facility permits the DTE to specify which network user identifier is to be used in conjunction with the NUI_Subscription facility or the NUI_Override facility or both facilities.

NUI_Selection may be requested in a CALL_REQUEST packet if the selected network user identifier has been agreed upon in conjunction with the NUI_Subscription facility or the NUI_Override facility. In addition, it may be requested in a CALL_ACCEPTED packet if the selected network user identifier has been agreed upon in conjunction with the NUI_Subscription facility.

Some networks may require that the NUI_Selection facility be requested by the DTE in every CALL_REQUEST packet and, possibly, in every CALL_ACCEPTED packet transmitted on a given DTE/DCE interface, when the NUI_Subscription facility has been agreed upon for a period of time for the interface.

If the network determines that the network user identifier is invalid or that any of the optional user facilities requested in the CALL REQUEST packet are not allowed for the DTE, it will clear the call.

6.22 Charging_Information

This optional user facility applies only to Virtual Call service in a DTE/DCE environment.

Charging_Information is an optional user facility which may be either agreed upon for a period of time or requested by the DTE for a given virtual call.

If the DTE is the DTE to be charged, the DTE can request the Charging_Information facility on a per call basis by means of an appropriate facility request (see §§ 7.2.1 and 7.2.2.8.1) in a CALL_REQUEST packet or CALL_ACCEPTED packet.

If a DTE subscribes to the Charging_Information facility for a contractual period, the facility is in effect for the DTE, whenever the DTE is the DTE to be charged.

Using the CLEAR_INDICATION or DCE_CLEAR_CONFIRMATION packet, the DCE will send to the DTE information about the charge for that call and/or other information which makes it possible for the user to calculate the charge.

6.23 RPOA Related Facilities

These optional user facilities apply only to Virtual Calls in a DTE/DCE environment.

The set of RPOA optional user facilities provides for the calling DTEs designation of a sequence of one or more RPOA transit network(s) within the originating country through which the call is to be routed when more than one RPOA transit network exists at a sequence of one or more gateways. In the case of international calls, this capability includes the selection of an international RPOA in the originating country.

6.23.1 RPOA_Subscription

RPOA_Subscription is an optional user facility agreed upon for a period of time for virtual calls. This user facility, if subscribed to, applies (unless overridden for a single virtual call by the RPOA_Selection facility) to all virtual calls where more than one RPOA transit network exist at a sequence of one or more gateways. The RPOA_Subscription facility provides a sequence of RPOA transit networks through which calls are to be routed. In the absence of both the RPOA_Subscription facility and RPOA_Selection facility (see § 6.23.2), no user designation of RPOA transit networks is in effect.

6.23.2 RPOA_Selection

RPOA_Selection is an optional user facility which may be requested by a DTE for a given virtual call (see §§ 7.2.1 and 7.2.2.9). It is not necessary to subscribe to the RPOA_Subscription facility in order to use this facility. This facility, when used for a given virtual call, applies for this virtual call only where more than one RPOA transit network exist at a sequence of one or more gateways. The RPOA_Selection facility provides a sequence of RPOA transit networks through which the call is to be routed. The presence of this facility in a call request packet completely overrides the sequence of RPOA transit networks that may have been specified by the RPOA_Subscription facility (see § 6.23.1).

If the DTE selects only one RPOA transit network, either the basic or extended format of the RPOA_Selection facility may be used. If the DTE selects more than one RPOA transit network, the extended format of the RPOA_Selection facility is used. The appearance of both formats in a CALL_REQUEST packet will be treated as a facility code not allowed.

To be in compliance with ANS X3.100:

- All networks shall implement basic RPOA_Selection.
- Networks shall also provide extended RPOA_Selection to DTEs that require it.

6.24 Hunt_Group

This optional user facility applies only to virtual calls in a DTE/DCE environment.

Hunt_Group is an optional user facility agreed upon for a period of time. This user facility, if subscribed to, distributes INCOMING_CALL packets having an address associated with the hunt_group across a designated grouping of DTE/DCE interfaces.

Selection is performed for an incoming virtual call if there is at least one idle logical channel, excluding one-way outgoing logical channels, available for virtual calls on any of the DTE/DCE interfaces in the group. Once a virtual call is assigned to a DTE/DCE interface, it is treated as a regular call.

When virtual calls are placed to a hunt_group address in the case where specific addresses have also been assigned to the individual DTE/DCE interfaces, the CLEAR_INDICATION packet (when no CALL_ACCEPTED packet has been transmitted) or the CALL_CONNECTED packet transferred to the calling DTE optionally will contain the called address of the selected DTE/DCE interface and the Called Line Address Modified Notification facility (see § 6.26) indicating the reason why the called address is different from the one originally requested.

Virtual calls may be originated by the DTEs on DTE/DCE interfaces belonging to the hunt_group; these are handled in the normal manner. In particular, the calling DTE address transferred to the remote DTE in the INCOMING_CALL packet is the hunt_group address unless the DTE/DCE interface has a specific address assigned. Permanent virtual circuits may be assigned to DTE/DCE interfaces belonging to the hunt-group. These permanent virtual circuits are independent of the operation of the hunt_group.

Some networks may

- apply virtual call subscription time user facilities in common to all DTE/DCE interfaces in the hunt_group,
- place a limit on the number of DTE/DCE interfaces in the hunt_group, and/or
- constrain the size of the geographic region that can be served by a single hunt_group.

6.25 Call_Redirection and Call_Deflection Related Facilities

These optional user facilities apply only to virtual call service in a DTE/DCE environment.

The set of Call_Redirection and Call_Deflection optional user facilities enables the redirection or the deflection of calls destined to one DTE (the "originally called DTE") to another DTE (the "alternative DTE"). The Call_Redirection facility (see § 6.25.1) allows the DCE, in specific circumstances, to redirect calls destined to the originally called DTE; no INCOMING_CALL packet is transmitted to the originally called DTE when such a redirection is performed. The Call_Deflection related facilities (see § 6.25.2) allow the originally called DTE to deflect individual incoming calls after reception of the INCOMING CALL packet by this originally called DTE. A DTE may subscribe to the Call_Redirection facility, to the Call_Deflection_Subscription facility, or to both.

When a call to which the Call_Redirection or Call_Deflection facilities are applied is cleared, the clearing cause shall be that generated during the last attempt to reach a called DTE/DCE interface.

Call_Redirection or Call_Deflection is limited to the network of the DTE originally called.

The basic service is limited to one Call_Redirection or Call_Deflection. In addition, some networks may permit a chaining of several Call_Redirections or Call_Deflections. In all cases, networks will ensure that loops are avoided and that the connection establishment phase has a limited duration, consistent with the DTE time limit T21 (see Table D-2).

When the virtual call is redirected or deflected, the CLEAR INDICATION packet, when no CALL_ACCEPTED packet has been transmitted by any DTE or the CALL_CONNECTED packet transferred to the calling DTE will contain the called address of the alternative DTE and the Called_Line_Address_Modified_Notification facility (see § 6.26), indicating the reason why the called address is different from the one originally requested.

When the virtual call is redirected or deflected, some networks may indicate to the alternative DTE that the call was redirected or deflected, the reason for redirection or deflection, and the address of the originally called DTE, using the Call_Redirection or Call_Deflection_Notification facility (see § 6.25.3) in the INCOMING_CALL packet.

Further information on the coding of the alternative DTE address is given in Appendix V, "Addresses in Call Set-up and Clearing Packets."

6.25.1 Call_Redirection

Call_Redirection is an optional user facility agreed upon for a period of time. This user facility, if subscribed to, redirects INCOMING_CALL packets destined to this DTE when:

- the DTE is out-of-order,
- the DTE is busy, or

  Some networks may provide Call_Redirection only in case #1. Some networks may offer, in addition,
- systematic Call_Redirection due to a prior agreement with the subscriber other than #1 and #2 above, agreed to between the network and the subscriber.

In addition to the basic service, some networks may offer either one of the following (mutually exclusive) capabilities:

- A list of alternate DTEs (C1, C2, ...) is stored by the network of the originally called DTE (DTE B). Consecutive attempts of Call_Redirection are tried to each of these addresses, in the order of the list, up to the completion of the call.

- Call_Redirections may be logically chained; if DTE C has subscribed to Call_Redirection to DTE D, a call redirected from DTE B to DTE C may be redirected to DTE D; Call_Redirections and Call_Deflections may also be chained.

The order of call set-up processing at the originally called DCE as well as the alternative DCE will be according to the sequence of call progress signals in Table 1/CCITT Recommendation X.96. For those networks that provide systematic Call_Redirection due to a prior request by the subscriber, the systematic Call_Redirection request will have the highest priority in the call set-up processing sequence at the originally called DCE.

6.25.2 Call_Deflection Related Facilities

6.25.2.1 Call_Deflection_Subscription

Call_Deflection_Subscription is an optional user facility agreed upon for a period of time. This facility, if subscribed to, enables the DTE to request, by using the Call_Deflection_Selection facility (see § 6.25.2.2), that an individual call presented to it by transmission of an INCOMING_CALL packet be deflected to an alternative DTE.

The DCE may use a network timer, with a value agreed to with the subscriber, to limit the time between the transmission to the originally called DTE of an INCOMING_CALL packet and the request by this originally called DTE to deflect the call. Once this timer has expired, the originally called DTE will no longer be permitted to use the Call_Deflection_Selection facility to deflect the call. If the originally called DTE tries to deflect the call after the expiration of this internal timer, the network clears the call.

6.25.2.2 Call_Deflection_Selection

Call_Deflection_Selection is an optional user facility which may be used on a per virtual call basis. This facility may be requested by a DTE only if it has subscribed to the Call_Deflection_Subscription facility (see § 6.25.2.1).

The Call_Deflection_Selection facility (see §§ 7.2.1 and 7.2.2.10) may be used by the called DTE in the CLEAR_REQUEST packet only in direct response to an INCOMING_CALL packet to specify the alternative DTE address to which the call is to be deflected. If the Call_Deflection_Selection facility is used in the CLEAR_REQUEST packet, then the DTE must also include any CCITT-specified DTE facilities and user data to be sent to the alternative DTE. Up to 16 octets of user data may be included in the CLEAR_REQUEST packet in this case, if the original call was established without fast select; up to 128 octets of user data may be included in the CLEAR_REQUEST packet if the original call was established with fast select. If no CCITT-specified DTE facilities are included in the CLEAR_REQUEST packet, then there will be none in the INCOMING CALL packet to the alternative DTE. If no clear user data is included in the CLEAR_REQUEST packet, then no call user data will be included in the INCOMING_CALL packet to the alternative DTE. When requested for a given virtual call, the network deflects the call to the alternative DTE and does not respond to the calling DTE as a result of the clearing at the originally called DTE/DCE interface. The X.25 facilities that are present in the INCOMING_CALL packet transmitted to the alternative DTE are those that would have been present in the INCOMING_CALL packet if the call was a direct call from the calling DTE to the alternative DTE; moreover, the Call_Redirection or Call_Deflection_Notification facility (see § 6.25.3) may also be present, if supported by the network.

Note:

For an interim period, some networks may not allow a deflected INCOMING_CALL packet's contents to be modified, in which case a deflecting DTE is not permitted to use any user data or CCITT-defined facilities in the CLEAR_REQUEST packet.

The bit 7 of the General Format Identifier (see § 4.3.3) in the INCOMING_CALL packet transmitted to the originally called DTE or the alternative DTE has the same value as the same bit in the CALL_REQUEST packet.

If the network offers only the basic service and if a Call_Redirection or Call_Deflection has already been performed, the DCE clears the call as indicated in Appendix C, "Packet Layer DCE Actions" when the Call_Deflection_Selection facility is used.

6.25.3 Call_Redirection_Or_Call_Deflection_Notification

Call_Redirection_Or_Call_Deflection_Notification is a user facility used by the DCE in the INCOMING_CALL packet to inform the alternative DTE:

- that the call has been redirected or deflected,
- why the call was redirected or deflected, and
- the address of the originally called DTE.

The following reasons can be indicated with the use of the Call_Redirection_Or_Call_Deflection_Notification facility (see §§ 7.2.1 and 7.2.2.11).

- Call_Redirection due to originally called DTE out of order.
- Call_Redirection due to originally called DTE busy.
- Call_Redirection due to prior request from the originally called DTE for systematic Call_Redirection.
- Call_Deflection by the originally called DTE.

  Some networks may also use the following reason in the network-dependent cases not described in this specification.

- Call distribution within a hunt group.

6.26 Called_Line_Address_Modified_Notification

This optional user facility applies only to virtual call service in a DTE/DCE environment.

Called_Line_Address_Modified_Notification is an optional user facility used by the DCE in the CALL_CONNECTED or CLEAR_INDICATION packets to inform the calling DTE as to why the called address in the packet is different from that specified in the CALL_REQUEST packet.

When more than one address applies to a DTE/DCE interface, the Called_Line_Address_Modified_Notification facility may be used by the DTE in the CLEAR_REQUEST packet (when no CALL_ACCEPTED packet has been transmitted) or the CALL_ACCEPTED packet, when the called address is present in the packet and different from that specified in the INCOMING_CALL packet. When this facility is received from the DTE, the DCE will clear the call if the called address is not one of those applying to the interface.

Note:

The DTE should be aware that a modification of any part of the called DTE address field without notification by the Called_Line_Address_Modified_Notification facility may cause the call to be cleared.

The following reasons can be indicated with the use of the Called_Line_Address_Modified_Notification facility in CALL_CONNECTED or CLEAR_INDICATION packets transmitted to the calling DTE:

- call distribution within a hunt_group;
- call redirection due to an originally called DTE being out-of-order;
- call redirection due to an originally called DTE being busy;
- call redirection due to a prior request from the originally called DTE for systematic call redirection;
- called DTE originated (more than one address applies to the DTE/DCE interface);
- call deflection by the originally called DTE.

In CALL_ACCEPTED or CLEAR_REQUEST packets, the reason indicated in conjunction with the use of the Called_Line_Address_Modified_Notification facility should be "Called DTE originated."

When several reasons could apply to a same call, the reason to be indicated by the network in the CALL CONNECTED or the CLEAR INDICATION packet by means of the Called_Line_Address_Modified_Notification facility is as specified below:

- The indication of a call redirection or call deflection in the network has precedence over the indication of distribution within a hunt group over a called DTE originated indication
- The called DTE originated indication has precedence over the indication of distribution within a hunt group
- When several call redirection or call deflection have been performed, the first one has precedence over the others

The called DTE address indicated in the CALL_CONNECTED or the CLEAR_INDICATION packet should correspond to the last DTE which has been reached or attempted to reach..

6.27 Transit_Delay_Selection_and_Indication

This optional user facility applies only to virtual call service in a DTE/DCE environment.

Transit_Delay_Selection_and_Indication is an optional user facility which may be requested by a DTE for a given virtual call. This facility permits selection and indication, on a per call basis, of the transit delay applicable to that virtual call as defined in § 4.3.8.

A DTE wishing to specify a desired transit delay in the CALL_REQUEST packet for a virtual call indicates the desired value (see §§ 7.2.1 and 7.2.2.12).

The network, when able to do so, should allocate resources and route the virtual call in a manner such that the transit delay applicable to that call does not exceed the desired transit delay.

The INCOMING_CALL packet transmitted to the called DTE and the CALL_CONNECTED packet transmitted to the calling DTE will both contain the indication of the transit delay applicable to the virtual call. This transit delay may be smaller than, equal to, or greater than the desired transit delay requested in the CALL_REQUEST packet.

Note:

During the interim period when this optional user facility is not yet supported by all networks, the indication of the transit delay applicable to the virtual call will not be provided in the INCOMING_CALL packet transmitted to the called DTE, if either a transit network or the destination network does not support this facility.

6.28 TOA/NPI_Address_Subscription

TOA/NPI_Address_Subscription (Type of Address/Numbering Plan Identifier) is an optional user facility agreed upon for a period of time for virtual calls.

When this facility is subscribed to, the DCE and the DTE will always use the TOA/NPI address format of the call set-up and clearing packets transmitted between the DCE and the DTE (see § 5.2.1).

When the DCE needs to transmit an INCOMING_CALL packet to a DTE which has not subscribed to this facility, and the calling DTE address to be transmitted in this packet cannot be contained in the non-TOA/NPI address format of the address block, the DCE will include no calling DTE address.

Note:

Some administrations may provide a subscription time option of the TOA/NPI address subscription facility, allowing the user to indicate that the DCE shall clear the call with the cause "Incompatible Destination" and a specific diagnostic in the case described in the last paragraph above, rather than include no calling DTE address.

Chapter 7. Formats for Facility Fields and Registration Fields

The formats described in this section apply only to optional user and CCITT-specified DTE facilities that may be present in the call setup and call clearing packets used in conjunction with the virtual call service.

7.1 General

The Facility field is present only when a DTE is using an optional user facility requiring some indication in

CALL_REQUEST,
INCOMING_CALL,
CALL_ACCEPTED,
CALL_CONNECTED,
CLEAR_REQUEST,
CLEAR_INDICATION packets or
DCE CLEAR_CONFIRMATION packets.

The Registration field is present

- in a REGISTRATION_REQUEST packet only when the DTE wishes to request the DCE to agree to or to stop a previous agreement for an optional user facility, and
- in a REGISTRATION_CONFIRMATION packet when the DCE wishes to indicate
  - which optional user facilities are available, or
  - which optional user facilities are currently in effect.

The Facility/Registration field contains one or more facility/registration elements. The first octet of each facility/registration element contains a Facility/Registration code to indicate the facility or facilities requested/negotiated. The remaining octets of a facility/registration element contain the Facility/Registration Parameter Field length, when present, and then the Facility/Registration Parameter Field.

Notes:

1. The action taken by the DTE when a facility code appears more than once is to use the last one. A DTE should not repeat a facility code.
2. A DTE may either ignore or treat as an error those facility codes that are not supported or that do not apply in a DTE/DTE environment. If the DTE chooses to treat these situations as an error, then it transmits a CLEAR_REQUEST packet across the interface with a cause indicating "DTE Originated" and the diagnostic "Facility Code Not Allowed."

The Facility/Registration codes are divided into four classes, by making use of bits 8 and 7 of the Facility/Registration code field, in order to specify Facility/Registration parameters consisting of '1', '2', '3', or a variable number of octets. The general class coding of the Facility/Registration code field is shown in Table 26.

Table 26: General Class Coding for Facility/Registration Code Fields		
CLASS	Bits 8 7 6 5 4 3 2 1	Characteristics
A	0 0 X X X X X X	Single Octet Parameter Field
B	0 1 X X X X X X	Double Octet Parameter Field
C	1 0 X X X X X X	Triple Octet Parameter Field
D	1 1 X X X X X X	Variable Length Parameter Field

For class 'D' the octet following the Facility/Registration code indicates the length, in octets, of the Facility/Registration parameter field. The Facility/Registration parameter field length is binary coded and bit 1 is the low order bit of this indicator.

The formats for the four classes are shown in Figure 7-1.

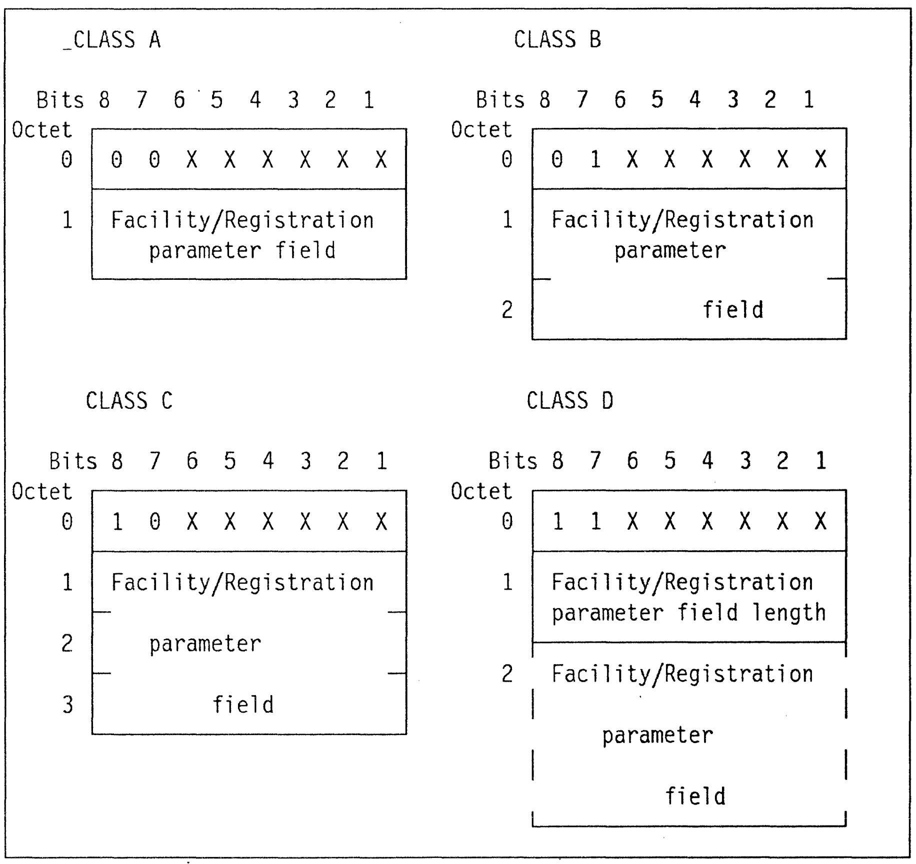


Figure 7-1. Facility/Registration Element - General Formats

The Facility/Registration code field is binary coded and, without extension, provides for a maximum of 64 Facility/Registration codes for classes 'A', 'B' and 'C' and '63' Facility/Registration codes for class 'D' giving a total of '255' Facility/Registration codes.

Facility/Registration code x'FF' is reserved for extension of the Facility/Registration code. The octet following this octet indicates an extended Facility/Registration code having the format 'A', 'B', 'C' or 'D' as defined above. Repetition of Facility/Registration code x'FF' is permitted and additional extensions thus result.

The coding of the Facility/Registration parameter field is dependent on the facility being requested/negotiated.

A Facility/Registration code may be assigned to identify a number of specific facilities, each having a bit in the parameter field indicating facility requested/facility not requested. In this situation, the parameter field is binary encoded with each bit position relating to a specific facility. A '0' indicates that the facility related to the particular bit is not requested and a '1' indicates that the facility related to the particular bit is requested. Parameter bit positions not assigned to a specific facility are set to zero. If none of the facilities represented by the Facility/Registration code is requested for a virtual call or for On-Line_Facility_Registration; the Facility/Registration code and its associated parameter field need not be present.

In addition to the Facility/Registration codes defined in § 7.2, other codes may be used for:

- non-X.25 facilities which may be provided by some networks (CALL_SET-UP and REGISTRATION packets);
- CCITT-specified_DTE facilities as described in Appendix I (Annex G of CCITT Recommendation X.25) for CALL_SET-UP, CLEAR_REQUEST and CLEAR_INDICATION packets.

IBM SNA DTEs may reject received packets indicating facility/registration codes that are unknown or not supported by Clearing the virtual call, resetting the permanent virtual circuit or Restarting the DTE/DCE interface with appropriate Cause and Diagnostic codes (see Appendix H, "DTE-Generated Diagnostic Codes").

Facility/Registration markers, consisting of a single octet pair, are used to separate requests for X.25 facilities as defined in §§ 6 and 7 from other categories as defined above, and, when several categories of facilities are simultaneously present, to separate these categories from each other.

The first octet of the marker is a Facility/Registration code field and is set to zero. The second octet is a Facility/Registration parameter field.

The Facility/Registration parameter field of a marker is set to zero when the marker precedes requests for:

- Registration codes specific to the local network (REGISTRATION packets);

- non-X.25 facilities provided by the network in case of intranetwork calls (CALL_SET-UP packets); and,
- non-X.25 facilities provided by the network to which the calling DTE is connected, in case of inter-network calls (CALL_SET-UP packets).

The facility parameter field of a marker is set to x'FF' when the marker precedes requests for non-X.25 facilities provided by the network to which the called DTE is connected, in case of inter-network calls (CALL_SET-UP packets).

The facility parameter field of a marker is set to x'0F' when the marker precedes request for CCITT-specified_DTE facilities.

All network(s) will support the facility marker with a facility parameter field set to x'FF' or x'0F'.

DTEs shall not use a facility marker with a facility parameter field set to x'FF' in case of intranetwork calls. However, if a DTE uses such a marker in an intranetwork call, the DCE is not obliged to clear the call, and the marker, with the corresponding facility requests, may be transmitted to the remote DTE.

Facility/Registration codes for X.25 facilities and for the other categories of facilities may be simultaneously present. However, requests for X.25 facilities must precede the other requests, and requests for CCITT-specified_DTE facilities must follow the other requests.

The coding of CCITT-specified_DTE facilities should comply with the description in Appendix G, "CCITT-Specified_DTE Facilities." However, the DCE is not required to verify that compliance. If the network verifies that compliance and finds an error, it may clear the call with the cause "Invalid Facility Request." The CCITT-specified_DTE facilities are otherwise passed unchanged by public data networks between the two packet-mode DTEs.

7.2 Coding of Facility Field in Call Set-up and Clearing Packets

The coding of the Facility_Code field and the format of the Facility_Parameter field are the same in the various Call_Set-up and Clearing packets in which they are used.

7.2.1 Coding of the Facility Code Fields

Table 27 gives the coding of the Facility_Code fields and the packet types in which they may be present.

Table 27: Coding of the Facility Code Field								
Facility / Packet Type	CRQ	INC	CAK	CCN	CLR	CLI	NCC	Facility Code Bit 8 7 6 5 4 3 2 1
Flow Control Parameter Negotiation	X	X	X	X				
− Packet Size								0 1 0 0 0 0 1 0
− Window Size								0 1 0 0 0 0 1 1
Throughput Class Negotiation	X	X	X	X				0 0 0 0 0 0 1 0
Closed User Group Selection	X	X						
− Basic Format								0 0 0 0 0 0 1 1
− Extended Format								0 1 0 0 0 1 1 1
CUG with Outgoing Access Selection	X	X						
− Basic Format								0 0 0 0 1 0 0 1
− Extended Format								0 1 0 0 1 0 0 0
Bilateral Closed CUG Selection	X	X						0 1 0 0 0 0 0 1
Reverse Charging	X	X						0 0 0 0 0 0 0 1 *1
Fast Select	X	X						
NUI Selection	X		X *2					1 1 0 0 0 1 1 0
Charging Information								
− requesting service	X		X					0 0 0 0 0 1 0 0
− receiving information						X	X	
. monetary unit								1 1 0 0 0 1 0 1
. segment count								1 1 0 0 0 0 1 0
. call duration								1 1 0 0 0 0 0 1
RPOA Selection	X							
− Basic Format								0 1 0 0 0 1 0 0
− Extended Format								1 1 0 0 0 1 0 0
Call Deflection Selection					X *4			1 1 0 1 0 0 0 1
Call Redirection or Deflection Notification		X						1 1 0 0 0 0 1 1
Called Line Address Modified Notification			X *3	X	X 3*4	X		0 0 0 0 1 0 0 0
Transit Delay Selection and Indication	X	X		X				0 1 0 0 1 0 0 1
Marker (see § 7.1)	X	X	X	X	X	X	X	0 0 0 0 0 0 0 0
Reserved for Extension								1 1 1 1 1 1 1 1

*1: This facility code and associated facility parameter will be present in the INCOMING_CALL packet if either or both of
REVERSE_CHARGING (if REVERSE_CHARGING_ACCEPTANCE is subscribed to or
FAST_SELECT (if FAST_SELECT_ACCEPTANCE is subscribed to) is indicated.
They may, but need not necessarily, be present if neither
REVERSE_CHARGING_ACCEPTANCE nor
FAST_SELECT_ACCEPTANCE are subscribed to.

*2: This facility code and associated facility parameter may be present in CALL_ACCEPTED packet only in conjunction with the NUI_Subscription facility (see § 6.21.3).

*3: Only when the reason "Called DTE Originated" is used in the parameter field (see §§ 6.26 and 7.2.2.12).

*4: The DTE is not allowed to use both Call_Deflection Selection and Called_Line_Address_Modified_Notification facilities in the same CLEAR_REQUEST packet.

7.2.2 Coding of the Facility Parameter Fields

7.2.2.1 Flow_Control_Parameter_Negotiation Facility

- Packet Size

  The packet size for the direction of transmission from the called DTE is indicated in bits 4, 3, 2 and 1 of the first octet of the Facility_Parameter field. The packet size for the direction of transmission from the calling DTE is indicated in bits 4, 3, 2 and 1 of the second octet. Bits 8, 7, 6 and 5 of each octet must be zero.

  The four bits indicating each packet size are binary coded and express the logarithm base 2 of the number of octets of the maximum packet size.

  Networks may offer values from 4 to 12, corresponding to packet sizes of 16, 32, 64, 128, 256, 512, 1024, 2048 or 4096, or a contiguous subset of these values. All Administrations will provide a packet size of '128' octets.

- Window Size

  The window size for the direction of transmission from the called DTE is indicated in bits 7 through 1 of the first octet of the Facility_Parameter field. The window size for the direction of transmission from the calling DTE is indicated in bits 7 through 1 of the second octet. Bit 8 of each octet must be zero.

  The bits indicating each window size are binary coded and express the size of the window. A value of zero is not allowed.

  Window sizes of 8 to 127 are only valid if extended sequence numbering is used (see § 6.2). The ranges of contiguous values allowed by a network with normal numbering and extended numbering are network dependent. All Administrations will provide a window size of '2'.

7.2.2.2 Throughput_Class_Negotiation Facility

The throughput class for the direction of data transmission from the called DTE is indicated in bits 8, 7, 6 and 5. The throughput class for the direction of data transmission from the calling DTE is indicated in bits 4, 3, 2 and 1.

The four bits indicating each throughput class are binary coded and correspond to the throughput classes indicated in Table 28.

Table 28: Coding of Throughput Classes					
bits / or / bits	4 / 8	3 / 7	2 / 6	1 / 5	Throughput Class (Bit/s)
	0	0	0	0	Reserved
	0	0	0	1	Reserved
	0	0	1	0	Reserved
	0	0	1	1	75
	0	1	0	0	150
	0	1	0	1	300
	0	1	1	0	600
	0	1	1	1	1,200
	1	0	0	0	2,400
	1	0	0	1	4,800
	1	0	1	0	9,600
	1	0	1	1	19,200
	1	1	0	0	48,000
>	1	1	0	1	64,000
	1	1	1	0	Reserved
	1	1	1	1	Reserved

7.2.2.3 Closed_User_Group_Selection Facility

- Basic Format

  The index to the closed user group selected for the virtual call is in the form of two decimal digits. Each digit is coded in a semi-octet in binary coded decimal with bit 5 being the low order bit of the first digit and bit 1 being the low order bit of the second digit.

  Indexes to the same closed user group at different DTE/DCE interfaces may be different.

- Extended Format

  The index to the closed user group selected for the virtual call is in the form of four decimal digits. Each digit is coded in a semi-octet in binary coded decimal with bit 5 of the first octet being the low order bit of the first digit, bit 1 of the first octet being the low order bit of the second digit, bit 5 of the second octet being the low order bit of the third digit and bit 1 of the second octet being the low order bit of the fourth digit.

  Indexes to the same closed user group at different DTE/DCE interfaces may be different.

7.2.2.4 Closed_User_Group_with_Outgoing_Access_Selection Facility

- Basic Format

  The index to the closed user group selected for the virtual call is in the form of two decimal digits. Each digit is coded in a semi-octet in binary coded decimal with bit 5 being the low order bit of the first digit and bit 1 being the low order bit of the second digit.

  Indexes to the same closed user group at different DTE/DCE interfaces may be different.

- Extended Format

  The index to the closed user group selected for the virtual call is in the form of four decimal digits. Each digit is coded in a semi-octet in binary coded decimal with bit 5 of the first octet being the low order bit of the first digit, bit 1 of the first octet being the low order bit of the second digit, bit 5 of the second octet being the low order bit of the third digit and bit 1 of the second octet being the low order bit of the fourth digit.

  Indexes to the same closed user group at different DTE/DCE interfaces may be different.

7.2.2.5 Bilateral_Closed_User_Group_Selection Facility

The Bilateral_Closed_User_Group facility and, thus, the Bilateral_Closed_User_Group_Selection facility is not used in SNA environments.

7.2.2.6 Reverse_Charging and Fast_Select Facilities

The coding of the facility parameter field is:

Bit 1 = 0 for Reverse_Charging not requested

1 for Reverse_Charging requested

Bit 8 = 0, and

Bit 7 = 0 or 1 for Fast_Select not requested (see Note 2)

Bit 8 = 1, and

Bit 7 = 0 for Fast_Select requested with no restriction on response

1 for Fast_Select requested with restriction on response

Notes:

1. Bits 6, 5, 4, 3, and 2 may be assigned to other facilities in the future; presently, they are set to '0'.
2. In a CALL_REQUEST packet, a DTE shall set bit 8 equal to 0 and bit 7 equal to 0 for Fast_Select not requested. In an INCOMING CALL packet, however, a DTE shall interpret bit 8 set to 0 and bit 7 set to 0 or 1 as Fast_Select not requested.

7.2.2.7 NUI_Selection Facility

The octet following the Facility_Code field indicates the length, in octets, of the Facility_Parameter field. The following octets contain the network user identifier, in a format determined by the network Administration.

7.2.2.8 Charging_Information Facility

- Parameter Field for Requesting Service

  The coding of the Facility_Parameter field is:

  Bit 1 = 0 for Charging_Information not requested
  1 for Charging_Information requested

  Note:

  Bits 8, 7, 6, 5, 4, 3, and 2 may be assigned to other facilities in the future; presently, they are set to '0'.

- Parameter Field Indicating Monetary Unit

  The octet following the Facility_Code field indicates the length, in octets, of the Facility_Parameter field.

  The parameter field indicates the charging. The coding of the parameter remains a subject for further study by the CCITT.

- Parameter Field Indicating Segment Count

  The octet following the Facility_Code field indicates the length, in octets, of the Facility_Parameter field and has the value n x 8 where 'n' is the number of different tariff periods managed by the network. The Facility Parameter Field follows the length and indicates the segment count for each tariff period.

  Each segment count is represented in the Facility Parameter Field by eight octets. For each tariff period, the first four octets of the Facility_Parameter field indicate the number of segments sent to the DTE. The following four octets indicates the number of segments received from the DTE.

  Each digit is coded in a semi-octet in binary coded decimal and bit 1 or bit 5 of each semi-octet is the low order bit of each digit and bits 4 through 1 of the last octet represent the lowest order digit of the segment count.

  Segment size and the specific packet types to be counted are a matter of the Administration in the case of national calls and are specified in CCITT Recommendation D.12 for international calls.

  Note:

  The relationship between a particular tariff period and its place in the parameter field is a national matter. The order is given by each Administration.

- Parameter Field Indicating Call Duration

  The octet following the Facility_Code field indicates the length, in octets, of the Facility_Parameter field and has the value n x 4 where 'n' is the number of different tariff periods managed by the network. The Facility Parameter Field follows the length and indicates the call duration for each tariff period.

Each call duration is represented in the Facility Parameter Field by four octets. For each tariff period, the first octet of the Facility_Parameter field indicates number of days, the second indicates number of hours, the third indicates number of minutes and the fourth indicates number of seconds. Each digit is coded in a semi-octet in binary coded decimal and bit 1 or bit 5 of each semi-octet is the low order bit of each digit. Bits 4 through 1 of each octet represent the low order digit.

Note:

The relationship between a particular tariff period and its place in the parameter field is a national matter. The order is given by each Administration.

7.2.2.9 RPOA_Selection Facility

- Basic Format

  The parameter field contains the data network identification code for the requested initial RPOA transit network and is in the form of four decimal digits.

  Each digit is coded in a semi-octet in binary coded decimal with bit 5 of the first octet being the low order bit of the first digit, bit 1 of the first octet being the low order bit of the second digit, bit 5 of the second octet being the low order bit of the third digit and bit 1 of the second octet being the low order bit of the fourth digit.

- Extended Format

  The octet following the Facility_Code field indicates the length, in octets, of the Facility Parameter field and has the value n x 2, when 'n' is the number of RPOA transit networks selected. The Facility Parameter Field follows the length and indicates the data network identification code for each RPOA transit network.

  Each RPOA transit network is indicated by a data network identification code, and is in the form of four decimal digits. Each digit is coded in a semi-octet in binary coded decimal with bit 5 of the first octet being the low order bit of the first digit, bit 1 of the first octet being the low order bit of the second digit, bit 5 of the second octet being the low order bit of the third digit and bit 1 of the second octet being the low order bit of the fourth digit.

  RPOA transit networks should appear in the Facility_Parameter field in the order that the calling DTE wishes them to be traversed.

7.2.2.10 Call_Deflection_Selection Facility

The octet following the facility code indicates the length, in octets, of the facility parameter field and has the value n + 2, where n is the number of octets necessary to hold the called address of the DTE to which the call is to be deflected (the alternative DTE).

The first octet of the facility parameter field indicates the reason for the DTE deflecting the call. The coding of this octet is as follows.

Coding of Call Deflection Reason Field	
bits 8 7 6 5 4 3 2 1	**Reason**
1 1 0 0 0 0 0 0	Call deflection by the originally called DTE.
1 1 0 0 0 0 0 1	Call deflection by gateway as a result of call redirection due to originally called DTE busy.
1 1 0 0 1 0 0 1	Call deflection by gateway as a result of call redirection due to originally called DTE out of order.
1 1 0 0 1 1 1 1	Call deflection by a gateway as a result of call redirection due to prior request from originally called DTE for systematic call redirection. (Note a)
Note a) Applies where the originally called DTE is on a private network and the call redirection is to a DTE address on the public network that presented the incoming call to the private network.	

The second octet indicates the number of semi-octets in the alternate DTE address. This address length indicator is binary coded and bit 1 is the low order bit. Its value is limited to 15 when the A bit is set to 0 (see § 5.2.1), to 17 when the A bit is set to 1.

The following octets contain the alternative DTE address, using coding which corresponds to the coding of the called DTE address field in the address block (see § 5.2.1). When the number of semi-octets of the alternative DTE address is odd, a semi-octet with zeros in bits 4, 3, 2 and 1 will be inserted after the last semi-octet in order to maintain octet alignment.

7.2.2.11 Call_Redirection or Call_Deflection_Notification Facility

The octet following the Facility_Code field indicates the length, in octets, of the Facility Parameter field and has the value n + 2, where 'n' is the number of octets necessary to hold the originally called DTE address. The Facility Parameter Field follows the length and indicates the reason for the redirection as well as the originally-called DTE address.

The first octet of the Facility_Parameter field indicates the reason for the Call_Redirection or Call_Deflection and has one of the following values.

Coding of Call Deflection or Call Redirection Reason Field

8	7	6	5	4	3	2	1	Reason
0	0	0	0	0	0	0	1	Originally called DTE busy
0	0	0	0	0	1	1	1	Call distribution within a hunt group (Note a)
0	0	0	0	1	0	0	1	Originally called DTE out-of-order
0	0	0	0	1	1	1	1	Systematic call redirection
1	1	0	0	0	0	0	0	Call deflection by a the originally called DTE (Note b)
1	1	0	0	0	0	0	1	Call deflection by gateway as a result of call redirection due to originally called DTE busy (Notes b & c)
1	1	0	0	1	0	0	0	Call deflection by gateway as a result of call redirection due to originally called DTE out-of-order (b & c)
1	1	0	0	1	1	1	1	Call deflection by gateway as a result of call redirection due to prior request from originally called DTE for systematic call redirection (Notes b & c)

Note a) This value may be used by some networks for network-dependent reasons not described in this architecture.
Note b) These codes are those set by the DTE in the Call_Deflection_Selection facility (see §7.2.2.10).
Note c) Applies where the originally called DTE is on a private network and the call redirection is to a DTE address on the public network that presented the incoming call to the private network.

The second octet indicates the number of semi-octets in the originally called DTE address. This address length indicator is binary coded and bit 1 is the low order bit. Its value is limited to 15 when the A bit is set to 0 (see § 5.2.1), to 17 when the A bit is set to 1.

The following octets contain the originally called DTE address. When both the calling DTE and the alternative DTE have subscribed to the TOA/NPI address subscription facility (see § 6.28), or when none of them have subscribed to this facility, the originally called DTE address is coded identically to the called DTE address field in the CALL_REQUEST packet. When these conditions are not satisfied, the network converts from one address format to the other (see § 3.2.1). When the number of semi-octets of the originally DTE address is odd, a semi-octet with zeros in bits 4, 3, 2 and 1 will be inserted after the last semi-octet in order to maintain octet alignment.

7.2.2.12 Called_Line_Address_Modified_Notification Facility

The coding of the Facility_Parameter field for Called_Line_Address_Modified_Notification is as follows.

Coding of Facility Parameter Field for Called_Line_Address_Modified_Notification

bits 8	7	6	5	4	3	2	1	Reason
X	0	0	0	0	0	0	1	Call redirection due to called DTE busy (Note a)
X	0	0	0	0	1	1	1	Call distribution within a hunt group (Note a)
X	0	0	0	1	0	0	1	Call redirection due to called DTE out-of-order (Note a)
X	0	0	0	1	1	1	1	Call redirection due to prior DTE request for systematic call redirection (Note a)
1	1	0	0	0	0	0	0	Call deflection by a the originally called DTE
1	1	0	0	0	0	0	1	Call deflection by gateway as a result of call redirection due to originally called DTE busy (Notes b & c)
1	1	0	0	1	0	0	1	Call deflection by gateway as a result of call redirection due to originally called DTE out-of-order (b & c)
1	1	0	0	1	1	1	1	Call deflection by gateway as a result of call redirection due to prior request from originally called DTE for systematic call redirection (Notes b & c)

Note a) The bit indicated as "X" set to 0 indicates that the called line address modification occurred in a public data network and set to 1 indicates it occurred in a public data network.

Note b) These codes are those set by the DTE in the Call_Deflection_Selection facility (see § 7.2.2.10).

Note c) Applies where the originally called DTE is on a private network and the call redirection is to a DTE address on the public network that presented the incoming call to the private network.

Note:

Bit 8, when received from the called DTE and when it is not set to '1', is forced to '1' by the DTE.

7.2.2.13 Transit_Delay_Selection_and_Indication Facility

This parameter is two octets. Transit delay is expressed in milliseconds, binary coded, with bit 8 of octet 1 being the high order bit and bit 1 of the octet 2 being the low order bit. The expressed transit delay may have a value from 0 to 65534 (all bits set to 1 but the low order bit).

Note:

During the interim period when this optional user facility is not yet supported by all networks, the transit delay indicated in the CALL_CONNECTED packet transmitted to the calling DTE should have a value of 65535 (all ones) when either a transit network involved in the virtual call or the destination network does not support this facility. So, this value should be interpreted by the calling DTE as an indication that the actual transit delay cannot be transmitted to it.

7.3 Coding of the Registration Field of Registration Packets

The coding of the Registration_Code field and the format of the Registration_Parameter field are the same in REGISTRATION_REQUEST and REGISTRATION_CONFIRMED packets in which they are used.

7.3.1 Coding of the Registration Code Fields

Table 29 gives the coding of the Registration_Code fields and the packet types in which they may be present.

Table 29: Coding of the Registration Code Field

Facility	May be Used in RRQ	May be Used in RCN	Registration Code Bits 8 7 6 5 4 3 2 1
Facilities that may be negotiated only when all logical channels use for virtual calls are in state p1	X	X	0 0 0 0 0 1 0 1
Facilities that may be negotiated at anytime	X	X	0 1 0 0 0 1 0 1
Availability of facilities		X	0 1 0 0 0 1 1 0
Non-Negotiable facilities values		X	0 0 0 0 0 1 1 0
Default Throughput Classes Assignment	X	X	0 0 0 0 0 0 1 0
Non-Standard default packet sizes	X	X	0 1 0 0 0 0 1 0
Non-Standard default window sizes	X	X	0 1 0 0 0 0 1 1
Logical Channel Types Ranges	X	X	1 1 0 0 1 0 0 0

Note: It is for further study whether or not the Call_Redirection facility may be negotiated.

The absence of a Registration_Code in the REGISTRATION_REQUEST packet means that the DTE does not want to modify the previous agreement for the concerned facility(ies).

The absence of a Registration_Code in a REGISTRATION_CONFIRMATION packet means that the concerned facility(ies) is not supported by the DCE or is not permitted by the DCE to be negotiated by the On-Line_Facility_Registration facility.

DTEs and DCEs should discard Registration_Elements with Registration_Codes that they do not support or do not know.

7.3.2 Coding of Registration Parameter Fields

7.3.2.1 Restricted Negotiable Facilities

(Facilities that may be negotiated only when all Logical Channels used for Virtual Calls are in State p1).

Each one of the following bits of the Registration_Parameter field corresponds to one facility that may be negotiated only when all logical channels for virtual calls are in state p1 (see Appendix F, "On-Line Registration Facility Applicability") and that needs only a single bit value to indicate its value. The correspondence between bits and facilities is given below.

```
Bit 8   }
Bit 7   }
Bit 6   }   Reserved for future use (see Note 1)
Bit 5   }
Bit 6   }
Bit 3:  D-Bit_Modification facility
Bit 2:  Packet_Retransmission facility
Bit 1:  Extended_Packet_Sequence_Numbering facility (see Note 2)
```

Notes:

1. Bits 8, 7, 6, 5 and 4 should be ignored when received and set to '0' when transmitted by the DTE or DCE.
2. The exact method for negotiation of this facility is the subject of further study by the CCITT.

A bit set to '1/0' in a REGISTRATION_REQUEST packet means that the DTE asks for the DCE to invoke/revoke the corresponding facility.

A bit set to '1/0' in a REGISTRATION_CONFIRMATION packet means that the corresponding facility is invoked/revoked by the DCE.

7.3.2.2 Unrestricted Negotiable Facilities

Each one of the following bits of the Registration_Parameter field corresponds to one facility that may be negotiated at any time (see Appendix F, "On-Line Registration Facility Applicability"). The correspondence between bits and facilities is given below.

```
Octet 1
  Bit 8:  Reserved for future use (see Note)
  Bit 7:  Charging_Information facility (per interface basis)
  Bit 6:  Throughput_Class_Negotiation facility
  Bit 5:  Flow_Control_Parameter_Negotiation facility
  Bit 4:  Reverse_Charging_Acceptance facility
  Bit 3:  Fast_Select_Acceptance facility
  Bit 2:  Outgoing_Calls_Barred facility
  Bit 1:  Incoming_Calls_Barred facility

Octet 2
  Bit 8:  }
  Bit 7:  }
  Bit 6:  }
  Bit 5:  }    Reserved for future use (see Note)
  Bit 4:  }
  Bit 3:  }
  Bit 2:  }
  Bit 1:  }
```

Note:

Bit 8 of octet 1 and all bits of octet 2 should be ignored when received and set to '0' when transmitted by the DTE or DTE.

A bit set to '1/0' in a REGISTRATION_REQUEST packet means that the DTE asks for the DCE to invoke/revoke the corresponding facility.

A bit set to '1/0' in a REGISTRATION_CONFIRMATION packet means that the corresponding facility is invoked/revoked by the DCE.

7.3.2.3 Availability of Facilities

Each one of the following bits of the Registration_Parameter field corresponds to one facility whose availability must be indicated to the DTE. The correspondence between bits and facilities is given below.

```
Octet 1
  Bit 8:  Reverse_Charging facility (see Note 1)
  Bit 7:  Reverse_Charging_Acceptance facility
  Bit 6:  Charging_Information facility (per call basis) (see Note 1)
  Bit 5:  Charging_Information facility (per interface basis)
  Bit 4:  Called_Line_Address_Modified_Notification facility  (see Note 1)
  Bit 3:  D-Bit_Modification facility
  Bit 2:  Packet_Retransmission facility
  Bit 1:  Extended_Packet_Sequence_Numbering facility

Octet 2
  Bit 8:  }
  Bit 7:  }   Reserved for future use (see Note 2)
  Bit 6:  }
  Bit 5:  RPOA_Selection (per call basis) (see Note 1)
  Bit 4:  Logical_Channel_Types_Ranges registration facility
  Bit 3:  Non-Standard_Default_Packet_Sizes registration facility
  Bit 2:  Non-Standard_Default_Window_Sizes registration facility
  Bit 1:  Default_Throughput_Classes_Assignment registration facility
```

Notes:

1. A bit set to '1/0' for a corresponding facility indicates that it is available/not-available for use by the DTE; no further negotiation is required for these facilities.

2. Bits 8, 7 and 6 of octet 2 should be ignored when received and set to '0' when transmitted.

A bit set to '1/0' by the DCE in a REGISTRATION_CONFIRMATION packet means that the corresponding facility is available/not-available for use by the DTE or is available/not-available to be negotiated by the DTE.

7.3.2.4 Non-Negotiable Facilities Values

Each one of the following bits of the Registration_Parameter field corresponds to one facility which is not available for negotiation but whose value should be indicated to the DTE.

```
Bit 1:  Local_Charging_Prevention facility
```

Note:

Bits 8, 7, 6, 5, 4, 3 and 2 should be ignored when received and set to '0' when transmitted.

A bit is set to '1/0' in a REGISTRATION_CONFIRMATION packet when the DCE has invoked/revoked the corresponding facility.

7.3.2.5 Default Throughput Classes Assignment

The throughput class for the direction of data transmission from the DTE issuing the REGISTRATION_REQUEST packet is indicated in bits 8, 7, 6 and 5. The throughput class for the direction of data transmission to the DTE issuing the REGISTRATION packet is indicated in bits 4, 3, 2 and 1.

The four bits indicating each throughput class are binary coded and correspond to throughput classes as indicated in Table 28 (see § 7.2.2.2).

Note:

Registration applies only to facility values for virtual calls; it does not apply to facility values for permanent virtual circuits.

7.3.2.6 Non-Standard Default Packet Sizes

The packet size for the direction of data transmission to the DTE issuing the REGISTRATION_REQUEST packet is indicated in bits 4, 3, 2 and 1 of the first octet. The packet size for the direction of data transmission from the DTE issuing the REGISTRATION_REQUEST packet is indicated in bits 4, 3, 2 and 1 of the second octet. Bits 8, 7, 6 and 5 of each octet must be zero.

The four bits indicating each packet size are binary coded and express the logarithm base 2 of the number of octets of the maximum packet size.

Networks may offer values from 4 to 12, corresponding to packet sizes of 16, 32, 64, 128, 256, 512, 1024, 2048 and 4096, or a subset of these values. All Administrations will provide a packet size of '128' octets.

Note:

Registration applies only to facility values for virtual calls; it does not apply to facility values for permanent virtual circuits.

7.3.2.7 Non-Standard_Default_Window_Sizes

The window size for the direction of data transmission to the DTE issuing the REGISTRATION_REQUEST packet is indicated in bits 7 to 1 of the first octet. The window size for the direction of data transmission from the DTE issuing the REGISTRATION_REQUEST packet is indicated in bits 7 to 1 of the second octet. Bit 8 of each octet must be zero.

The bits indicating each window size are binary coded and express the size of the window. A value of zero is not allowed.

Window sizes of 8 to 127 are only valid when extended sequence numbering is used. The range of values allowed by a network are network dependent. All Administrations will provide a window size of '2'.

Note:

Registration applies only to facility values for virtual calls; it does not apply to facility values for permanent virtual circuits.

7.3.2.8 Logical Channel Types Ranges

The octet following the Registration_Code field indicates the length, in octets, of the Registration_Parameter field and shall indicate 14 octets. The Registration Parameter Field then consists of the following 14 octets.

Bits 4, 3, 2 and 1 of octets 1, 3, 5, 7, 9 and 11 of the Registration_Parameter field shall contain the logical channel group number for parameters LIC, HIC, LTC, HTC, LOC and HOC, respectively, (see Appendix A, "Logical Channel Ranges"). Bits 8, 7, 6 and 5 of these octets must be set to zero.

Octets 2, 4, 6, 8, 10 and 12 of the Registration_Parameter field shall contain the logical channel numbers for parameters LIC, HIC, LTC, HTC, LOC and HOC, respectively, (see Appendix A, "Logical Channel Ranges").

No one-way incoming logical channels is represented by LIC and HIC both equal to zero; no two-way logical channels is represented by LTC and HTC both equal to zero; and, no one-way outgoing logical channels is represented by LOC and HOC both equal to zero.

Bits 4, 3, 2 and 1 of octet 13 of the Registration_Parameter field shall contain the high order bits of the total number of logical channels to be used for virtual calls. Bits 8, 7, 6 and 5 of octet 13 must be set to zero. Octet 14 of the Registration_Parameter field shall contain the low order bits of the total number of logical channels to be used for virtual calls.

Notes:

1. The inequalities of Appendix A, "Logical Channel Ranges" must apply to non-zero values of LIC, HIC, LTC, HTC, LOC and HTC.
2. The total number of logical channels to be used for virtual calls as indicated in octets 13 and 14 is equal to the sum of the number of one-way incoming logical channels, two-way logical channels and one-way outgoing logical channels.

Chapter 8. Logical Link Control (LLC) on SNA-to-SNA Connections

In SNA-to-SNA environments virtual circuits are viewed by the higher layers as communication lines (physical media) with the ability to support multiple sessions. Permanent virtual circuits (PVCs) appear to the higher layers of SNA as dedicated (leased) lines, while virtual calls (VCs), often referred to as switched virtual circuits (SVCs), appear as switched (dial-up) lines.

In this environment a Logical Link Control (LLC) function is required to accommodate SNA adjacent node physical services equivalent to such SDLC functions as:

- identification information exchange (XID);
- operational mode selection (SNRM, SABM, etc.);
- link test (TEST); and,
- link disconnection (DISC);

as well as to enhance the quality of the underlying service exhibited in some environments.

Differences in the error detection and recovery characteristics of adjacent SNA nodes in Public Switched Telephone Network and Packet-Switched Data Network environments are shown in Figure 8-1 on page 8-3.

8.1 Introduction

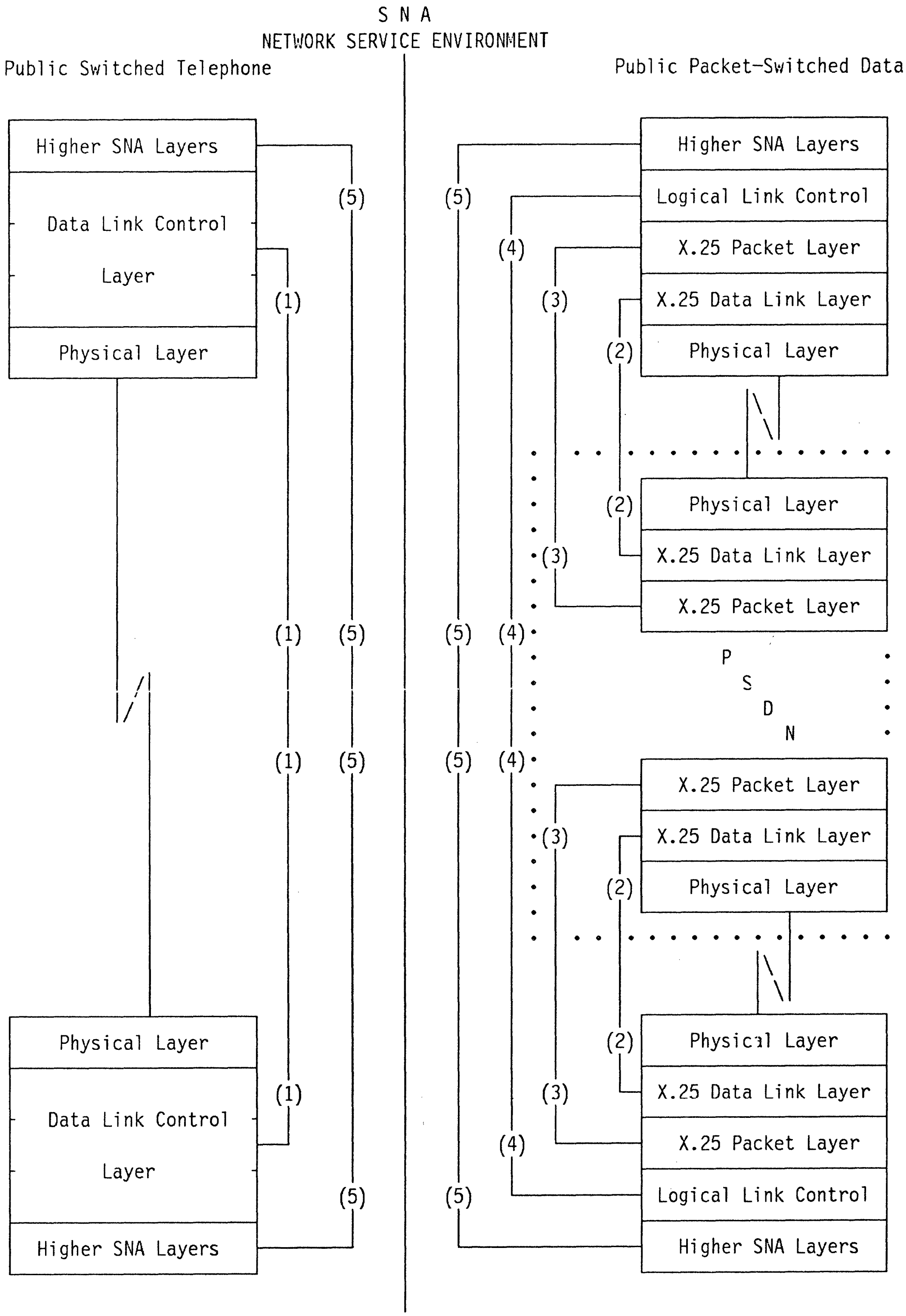
Three types of logical link control are defined:

1. BNN (Boundary Network Node) - Qualified Logical Link Control (QLLC) which employs the Qualified Data Indicator 'Q-bit' in X.25 DATA packets to identify unnumbered and supervisory (Receive_Ready) QLLC commands and responses. QLLC, described in Appendix O, "Description of the BNN_Qualified Logical Link Control - (QLLC) Procedures" on page O-1, is designed for use with PSDN virtual circuit services that exhibit quality of service characteristics that are acceptable to the user;
2. Physical Services Header (PSH) LLC which is employed in certain early IBM SNA X.25 DTE implementations and described briefly in Appendix J, "Physical Services Headers" on page J-1; and,
3. Enhanced Logical Link Control (ELLC) which employs extended HDLC formats and the procedures described in Appendix M, "Description of the Enhanced Logical Link Control - (ELLC) Procedures" on page M-1. ELLC provides error detection and optional retransmission recovery capabilities designed to enhance the quality exhibited by underlying virtual circuit services. While ELLC may be selected by the user on a virtual circuit basis, the optional retransmission capability applies to the DTE/DCE Interface and may be controlled by the value of LLC parameter LN2 (see "Maximum Number of LPDU Transmissions - (LN2)" on page M-24).

QLLC procedures described in Appendix O, "Description of the BNN_Qualified Logical Link Control - (QLLC) Procedures" on page O-1 are considered 'base architecture' for all IBM SNA X.25 DTEs except the IBM-5973 Network Interface Adapter (NIA) which supports only the PSH protocol. The optional ELLC procedures described in Appendix M, "Description of the Enhanced Logical Link Control - (ELLC) Procedures" on page M-1 may be supported by IBM SNA X.25 DTEs in environments where virtual circuit quality of service characteristics need to be enhanced to satisfy SNA user requirements. Consequently, IBM SNA X.25 DTEs that remotely attach to the IBM 5973 NIA must be capable of using PSH_LLC, as well as QLLC and, optionally, ELLC.

A Protocol_Identifier (PI) carried in the first octet of the Call_User_Data (CUD) field in X.25 CALL_REQUEST packets is used to select the LLC protocol and Cause_Code set (normal or extended) applicable for operation on SVCs. CALL_REQUEST packets for virtual calls desiring to use ELLC procedures have PI = x'C6' (or x'CE' for extended Cause Codes). DTEs that do not support ELLC, and IBM 5973s that support only PSH_LLC, reject such calls by sending a CLEAR_REQUEST packet with the 'DTE-Originated' cause code and the diagnostic code #12, 'Invalid LLC Type'. Calling DTEs may then reinitiate the call by sending a CALL_REQUEST packet with PI = x'C3' (or x'CB' for extended Cause Codes) requesting a connection for QLLC operation, or with PI = x'C2' to request a connection for PSH_LLC operation.

The LLC protocol used for operation on PVCs is established by bilateral agreement between communicating DTEs.



Legend:

1 - SDLC Error Detection and Retransmission Recovery or Reporting
2 - LAPB Error Detection and Retransmission Recovery or Reporting
3 - Virtual Circuit Error Detection and Reporting
4 - QLLC or ELLC Error Detection and Recovery or Reporting
5 - SNA Session-Level Error Recovery or Reporting

Figure 8-1. Error Detection and Recovery in Different Network Service Environments

Figure 8-2 on page 8-4 shows the correlation between ELLC/QLLC functions and equivalent SDLC functions.

ELLC Function	QLLC Function	SDLC Function	PSH LLC Function	Primary Command	Secondary Response	Peer-to-Peer	
						Command	Response
LI	UDP	I	DATA	X	X	X	
LSABME	QSM	SNRM/SABM	PSCONTACT	X		X	
LDISC	QDISC	DISC	PSDISC	X		X	
LXID	QXID	XID	PSXID	X	X	X	X
LTEST	QTEST	TEST	PSTEST	X	X	X	X
LUA	QUA	UA	PSCONTACT		X		X
–	QRD	RD	PSDISC		X		
LRR	QRR	RR	–	X	X	X	X
LRNR	–	RNR	–	X	X	X	X
LREJ	–	REJ	–	X	X	X	X
LDM	QDM	DM	–		X		X
LPDUR	QFRMR	FRMR	–		X		X

Note: PSH_LLC is primary/secondary only. ELLC is peer-to-peer only.
TBD – To Be Determined.

Figure 8-2. COMMAND/RESPONSE REPERTOIRE for ELLC versus QLLC versus SDLC and PSH_LLC

8.1.1 Call_User_Data (CUD) Field Format

The format of the CUD field for CALL_REQUEST and INCOMING_CALL packets on SNA-to-SNA connections is illustrated in Figure 8-3 on page 8-5.

8.1.1.1 Protocol_Identifier (PI)

The PI is mandatory and occupies the first octet of the CUD. It is used to distinguish between SNA-to-SNA connection and SNA-to-non_SNA connections as well as to select the LLC protocol to be used on SNA-to-SNA connections as described "Introduction" on page 8-1.

8.1.1.2 Field_Format_Identifier (FFI)

The FFI is optional and, when present, defines the format of the remainder of the CUD field. IBM SNA X.25 DTE implementations that use FFIs must make such use optional. IBM SNA X.25 DTEs that do not support FFIs must accept and ignore CUD fields of up to 15 octets in addition to the Protocol Identifier. Figure 8-4 on page 8-6 illustrates the format of the CUD field for the only optional FFI currently defined, b'xxxxxxx1' where the bits denoted by 'x's, bits 8 thru 2, are reserved and set to zeroes. The FFI should not be present as the last byte of the CUD, i. e., if there is no Call Control Indicator.

Octet	Bits 8	7	6	5	4	3	2	1
0	Protocol Identifier							
	1	1	x	x	DCI	1	1	0
	ELLC							
	or							
	1	1	x	x	DCI	0	1	1
	QLLC							
	or							
	1	1	x	x	0	0	1	0
	PSH							
1	(Optional) Field Format Identifier (FFI)							
2	ELLC Call Control Indicator							
	x	x	x	x	x	x	x	I/R
3 . 15	Format Specific Field							

```
N/A = Not Applicable (irrelevant).
I/R = '0' for initial connection.
    = '1' for connection recovery.
DCI = '0' for Standard DTE Diagnostic Codes and the
          DTE-Generated Cause Code x'00' (See Appendix H)
    = '1' for SNA Specific Diagnostic Codes and the
          DTE-Generated Cause Code x'80' for 1984/1988 X.25
    = '0' for SNA Specific Diagnostic Codes and the
          DTE-Generated Cause Code x'80' for 1980 X.25
Note: Bits indicated as 'x' are reserved and should be set to 0's
```

Figure 8-3. CALL_USER_DATA Field Format for CALL_REQUEST and INCOMING_CALL Packets on SNA-to-SNA Connections

8.1.1.3 ELLC_Call_Control_Indicator - (ELLC_CCI)

The ELLC_CCI (bit 1 of octet 2) is used to distinguish between initial connection requests and connection recovery requests, while the remaining bits, denoted by 'x's in Figure 8-3 and Figure 8-4 on page 8-6, are reserved and set to zero ('0's).

8.1.1.4 Connection_Identifier - (CID)

The CID is eight octets in length and permits IBM SNA X.25 DTEs to accept or reject incoming calls based on its content. The following rules apply to the use of the optional CID:

1. Some IBM SNA X.25 DTEs may not support the Connection_Identifier.

2. For IBM SNA X.25 DTEs that do support a Connection_Identifier, its use is optional on a per call basis at the discretion of the user.

3. IBM SNA X.25 DTEs that support Connection_Identifiers may reject incoming calls by transferring a CLEAR_REQUEST with the appropriate diagnostic code when the Connection_Identifier does not compare with one that is expected.

Octet	Bits 8	7	6	5	4	3	2	1
0	Protocol_Identifier							
	1	1	x	x	DCI	1	1	0
	ELLC							
	or							
	1	1	x	x	DCI	0	1	1
	QLLC							
	or							
	1	1	x	x	0	0	1	0
	PSH							
1	Field_Format_Identifier							
	x	x	x	x	x	x	x	1
2	ELLC_Call_Control_Indicator							
	x	x	x	x	x	x	x	I/R
3	Reserved							
	0	0	0	0	0	0	0	0
4 . 11	Connection_Identifier							

```
N/A = Not Applicable (irrelevant).
I/R = '0' for initial connection.
    = '1' for connection recovery.
DCI = '0' for Standard Diagnostic Codes and the
          DTE-Generated Cause Code x'00' (See Appendix H)
    = '1' for SNA Specific Diagnostic Codes and the
          DTE-Generated Cause Code x'80' for 1984/1988 X.25
    = '0' for SNA Specific Diagnostic Codes and the
          DTE-Generated Cause Code x'80' for 1980 X.25
```

Note: Bits indicated as 'x' are reserved and should be set to 0's

Figure 8-4. CUD Field Format for CALL_REQUEST and INCOMING_CALL Packets with Connection_Identifiers

Chapter 9. Other System Considerations

9.1 Virtual Circuit Parameter Considerations

Some system parameters that apply to the entire X.25 DTE/DCE interface or to particular portions of the interface and are agreed upon for a period of time with the network Administration. Others that apply only to virtual calls are established during call establishment.

9.1.1 Parameters Applicable to the Entire Interface

9.1.1.1 Non-Standard Default Window Size

Values other than '2' can be agreed upon with some network Administrations. This parameter has local significance and must be handled directly by the DTE. It will impact the amount of buffer used in the DTE.

9.1.1.2 Incoming Calls Barred

No parameter is needed at the DTE. The SNA control point should not enable the links (ports) to receive incoming calls.

9.1.1.3 Outgoing Calls Barred

No parameter is needed at the DTE. Its user should not issue calls. Calls will be cleared by the network and reporting to the control point or operator will be performed.

9.1.1.4 Single Closed User Group

No parameter is required at the DTE. Calls issued to a DTE outside of the CUG are cleared by the network. DTEs report the contents of Clearing Cause and Diagnostic Code fields to the SNA control point or to the local operator.

9.1.1.5 Incoming Calls Barred within a Single CUG

This is a combination of §§ 9.1.1.2 and 9.1.1.4.

9.1.1.6 Outgoing calls Barred with a Single CUG

This is a combination of §§ 9.1.1.3 and 9.1.1.4.

9.1.1.7 Multiple Closed User Groups

For support on incoming calls only, a parameter setting is needed in the DTE to permit handling of the indication in the facility field. For outgoing calls, the DTE needs a mechanism to select the desired CUG.

9.1.1.8 Reverse Charging Acceptance

The DTE must be informed that the facility has been subscribed to because the facility field in the INCOMING CALL packet will indicate Reverse Charging when a calling DTE has requested it.

A clever DTE should be able to detect reverse charged calls coming from callers that should not reverse charge to it. This is not feasible in NCP for lack of available inbound reporting at connection establishment time between NCP and SSCP.

9.1.1.9 Local Address

DTEs that use the calling DTE address field in CALL REQUEST packets must store their address locally for this purpose.

9.1.2 Parameters Applicable to Portions of the Interface

9.1.2.1 Number and Type of Virtual Circuits

All DTEs must support logical channel 0 as the path for RESTART and DIAGNOSTIC packets.

Single logical channel DTEs must use logical channel number '1' for data transfer, whether this single channel is supporting a PVC or a VC. The number and type (PVC or VC) of virtual circuits must be agreed upon with the network Administration for each DTE/DCE interface.

9.1.2.2 Non-Standard Default Packet Size

Maximum packet lengths of '16', '32', '64', (all networks offer '128'), '256', '512' or '1024' octets can be subscribed to when the network offers the corresponding facility. A single value applies for all logical channels assigned for Virtual Call service. An individual value can be selected for each PVC logical channel. These parameters are required at the DTE and must be in agreement with the network Administration.

When the network does not allow default value selection, only '128' applies, unless the negotiation facility is used for VCs. Note that in this case, only '128' can apply to PVCs.

9.1.2.3 One-way Logical Channel Incoming

No parameter is required at the DTE. Call requests are cleared by the network and DTEs report the contents of the Clearing Cause and Diagnostic Code fields to the SNA control point or to the local operator.

9.1.2.4 One-way Logical Channel Outgoing

The DTE must know which channels are reserved. In addition, a per call parameter is required to flag each call request received from the control point or the operator in order to authorize the DTE to choose one of the reserved channels.

9.1.3 Parameters Applicable per Call

These parameters must be given to the X.25 DTE/DCE interface handler at each call. They are not necessarily reflected on the interface. In the case of NCP, these parameters must be transmitted from the SSCP to NCP. In the present state of the architecture, the dial digit field of the SNA 'connect out' function can be used for this purpose.

Further architecture work is required to specify appropriate formats and procedures for this facility. Clearly, such a mechanism only permits selection of the facility as a function of the SNA node to be dialed - not as a function of the individual session requirements when the virtual circuit is shared among several sessions.

9.1.3.1 Selection of One-way Logical Channel Outgoing

This permits a call to be made using one of the channels reserved for outgoing only. Refer to § 9.1.2.4.

9.1.3.2 Packet Size Selection

If the nature of the applications requiring use of the VC is known, a specific parameter should indicate the requested packet size. If it is not known, the DTE should always initialize the negotiation with the maximum packet size it can support. The result of the negotiation need not be reported back to the operator or control point.

9.1.3.3 Throughput Class Negotiation

Because of potential cost-of-service reductions, multiple virtual circuit DTE's should implement Throughput Class Negotiation.

9.2 Security

9.2.1 SNA-to-SNA Connections

Called DTEs can implement a rudimentary calling DTE identification check by testing the calling DTE address in INCOMING CALL packets. DTEs can elect to implement as a user option the connection identifier capability defined for CALL REQUEST and INCOMING CALL packets. See "Connection_Identifier - (CID)."

Care must be exercised in choosing cryptographic techniques. Data link control level cryptographic products defined for SNA products are not defined for the X.25 link and packet levels and cannot be used. Cryptographic products defined for SNA above, and transparent to, the data link control level can be used.

9.2.2 SNA-to-non SNA Connections

Security techniques are specific to the particular non-SNA remote DTE being supported. In general, techniques used for SNA-to-SNA connections are not applicable.

9.3 Reliability, Availability and Serviceability (RAS)

RAS characteristics of PSDNs are not clearly established. However, numerous error detection and reporting mechanisms are included throughout this interface specification to aid in problem determination.

9.3.1 Philosophy

The fundamental philosophy adopted for error reporting in PSDN environments is one of commonality. IBM SNA X.25 DTEs cover a broad spectrum of RAS capabilities. Therefore, reporting to a higher layer may mean different things for different products. These can range from simply reporting an error condition to the local operator of a simple DTE to full compatibility with Network Problem Determination and Analysis programs.

A common set of Diagnostic Codes is specified in Appendix H, "DTE-Generated Diagnostic Codes" for use by all IBM SNA X.25 DTEs in reporting error conditions and abnormal situations to higher layers of SNA.

9.3.2 Summary of Error Conditions

Detectable error conditions are divided into four general categories:

1. those resulting from receipt of unsupported packet types (i.e., DCE_INTERRUPT packets);
2. those that can result from a discrepancy between the DTE and DCE interpretations of the state of some subscribed interface parameter (i.e., receipt of an INCOMING_CALL packet on a logical channel assigned for permanent virtual circuit service);
3. those most likely resulting from a malfunction of the DCE (i.e., receipt of an unsolicited DCE_RESTART_CONFIRMATION packet); and
4. those caused by failures at the physical layer or the data link layer (i.e., dropping of the Data Set Ready indication).

IBM SNA X.25 DTEs, upon detection of errors in category:

'1' or '2' - clear the virtual call or reset the permanent virtual circuit if such an action is permitted without violating any procedure. The error condition is reported to a higher layer of SNA; the received packet is discarded.

'3' - transmit a RESTART REQUEST packet across the DTE/DCE interface, place all virtual circuits in an inoperative state and report the error condition to the higher layers of SNA.

+ '4' - perform the LAPB Link_Resetting procedure and report the event to a
+ higher layer of SNA.

9.3.3 General Recommended Actions

All errors detected at the X.25 DTE/DCE interface, either by IBM SNA X.25 DTEs or their associated DCEs, that result in CLEAR, RESET or RESTART indications must be reported to the SNA control point or to the local operator, as appropriate. The Call Progress Signals (CPS) defined in CCITT Recommendation X.96 used for 'Network Generated' Cause and Diagnostic Codes defined in CCITT Recommendation X.25 and a common set of 'DTE-Originated' diagnostic codes defined in Appendix H, "DTE-Generated Diagnostic Codes" for IBM SNA X.25 DTEs to aid in problem determination are used for reporting purposes. Session outage notifications are propagated in accordance with general SNA mechanisms, using INOPERATIVE (INOP) to the control point and RECORD FORMATTED MAINTENANCE STATISTICS (RECFMS) or RECORD MAINTENANCE STATISTICS (RECMS) to Communication Network Management (CNM).

Further architectural definition is required to specify formats and procedures needed for:

- Inoperative (INOP) notifications generated by IBM SNA X.25 DTEs.
- Record Formatted Maintenance Statistics (RECFMSs) or Record Maintenance Statistics (RECMSs) generated by IBM SNA X.25 DTEs.
- Other network problem determination and analysis procedures.

9.4 Relationship to ISO_Open System Interconnection (OSI)

9.4.1 Protocol Identification

+ ISO DTR 9577, "Proposal for a New Work Item: Protocol Identification in the Network Layer," is envisioned as producing a Type 3 Technical Report to record the structure and values of Protocol Identifiers for the OSI Network Layer.

Two distinct protocol identifiers are currently proposed:

1. An Initial Protocol Identifier - (IPI) used to identify the first protocol operating directly above the Data Link Layer; and,

   - contained in the first octet of protocol control information (e.g., the first octet (octet '1') of X.25 packets),
   - structured as depicted in Figure 9-1 on page 9-6, and
   - decomposed according to the following procedure:
     a. if the value of IPI is non-zero, and bits 6 & 5 of the PD octet are binary zero, then:
        — bits 8 & 7 are examined to determine the administrative authority responsible for defining bits 4, 3, 2 & 1.
     b. if bits 6 & 5 have any value other than zero, then:
        — the remaining bits are interpreted according to the procedures defined in ISO-8208.
     c. if the value of the PD is zero, the
        — ISO-8473 Inactive Subset is identified.

2. A Subsequent Protocol Identifier - (SPI) used to identify the protocol operating over the first protocol.

   - contained in the first octet of Protocol Service Data carried by the initial protocol (e.g., octet '0' of CUD in X.25 Call Set-Up packets),
   - structured as depicted in Figure 9-2 on page 9-7, and
   - decomposed according to the following procedure:
     a. if the value of the SPI is non-zero, then:
        — bits 8 & 7 are examined to determine the administrative authority (if any) responsible for defining bits 6...1.
     b. bits 6 through 1 are then examined to ascertain the particular protocol identified by the SPI octet.

Bit Pattern 8 7 6 5 4 3 2 1	Allocation Category Protocol
0 0 0 0 x x x x	Allocation by CCITT
. . . 0 0 0 0	ISO-8473 Inactive Subset
. . . 0 0 0 1	CCITT T.70 Teletex Network (CSPDN Operation)
. . . 0 0 1 0	
. . . . . .	Reserved
. . . 0 1 1 1	
. . . 1 0 0 0	CCITT I.45I/Q.931 (ISDN)
. . . 1 0 0 1	
. . . . . .	Reserved
. . . 1 1 1 1	
0 1 0 0 x x x x	Allocation by National Bodies
1 0 0 0 x x x x	Allocation by ISO
. . . 0 0 0 0	– Reserved
. . . 0 0 0 1	ISO-8473 Connectionless Protocol
. . . 0 0 1 0	ISO-8473 ES-to-IS Routing (Provisional)
. . . 0 0 1 1	
. . . . . .	Reserved
. . . 1 1 1 0	
1 0 0 0 1 1 1 1	Reserved for Extension by N-5166
1 1 0 0 x x x x	Not Constrained by N-5166
x x 0 1 x x x x	ISO-8208/CCITT X.25 – Modulo 8
x x 1 0 x x x x	ISO-8208/CCITT X.25 – Modulo 128
x x 1 1 x x x x	ISO-8208/CCITT X.25 – GFI Extension

Figure 9-1. ISO/IEC TC_97/SC_6 N-5166 IPI Structure and Values

Bit Pattern 8 7 6 5 4 3 2 1	Allocation Category Protocol
0 0 x x x x x x	Allocation by CCITT
. 0 0 0 0 0 0	ISO-8473 Inactive Subset
. . . 0 0 0 1	CCITT X.29
. . . 0 0 1 0	CCITT T.70 Teletex Transport
. . . 0 0 1 1	ISO-8073 DAD1 and CCITT X.244
. . . . . .	
0 0 1 1 1 1 1 1	
0 1 x x x x x x	Allocation by National Bodies
1 0 x x x x x x	Allocation by ISO
. 0 0 0 0 0 0	- Reserved
. . . 0 0 0 1	ISO-8473 Connectionless Protocol
. . . 0 0 1 0	ISO DIS 9542 (Provisional)
. . . 0 0 1 1	ISO DIS 9068 (Provisional)
. . . 0 1 0 0	ISO-8878 Annex A (X.25 SNDCP)
. . . 0 1 0 1	Reserved
. . . . . .	
. 1 1 1 1 1 1	
1 1 0 0 0 0 0 0	Not Constrained by N-5166
1 1	
1 1 1 1 1 1 1 0	
1 1 1 1 1 1 1 1	Reserved for Extension by N-5166

Figure 9-2. ISO/IEC TC_97/SC_6 N-5166 SPI Structure and Values

SNA-Specific use of the first octet of the CUD field in X.25 Call Set-Up packets conforming to CCITT and ISO Protocol Identification is depicted in Figure 9-3 on page 9-8 and Figure 9-4 on page 9-8.

Bit Pattern 8 7 6 5 4 3 2 1	SNA/X.25 Protocol Identifier - (CUD Octet 0) Protocol
1 1 0 0 x x x x	SNA-Specific
. . x x 0 x	SNA-to-non_SNA
. . 0 0 1 0	SNA-to-SNA, PSH, x'00'
. . 0 0 1 1	SNA-to-SNA, QLLC, x'00'
. . 0 1 1 0	SNA-to-SNA, ELLC, x'00'
. . 0 1 1 1	SNA-Specific PI Extension, x'00'
. . 1 0 1 0	- Reserved
. . 1 0 1 1	SNA-to-SNA, QLLC, x'80'
. . 1 1 1 0	SNA-to-SNA, ELLC, x'80'
1 1 . 1 1 1 1	SNA-Specific PI Extension, x'80'
1 1 0 1 0 0 0 0	
. . . . .	- Reserved
1 1 . 0 1 1 0	
1 1 . 0 1 1 1	SNA-Specific PI Extension, x'00'
1 1 . 1 0 0 0	
. . . . . .	- Reserved
1 1 0 1 1 1 1 0	
1 1 0 1 1 1 1 1	SNA-Specific PI Extension, x'80'
1 1 1 0 x x 0 x	SNA-to-non_SNA
. . 0 0 1 0	- Reserved
. . 0 0 1 1	- Reserved
. . 0 1 1 0	- Reserved
1 1 . 0 1 1 1	SNA-Specific PI Extension, x'00'
1 1 . 1 0 1 0	
. . . . . .	- Reserved
1 1 . 1 1 1 0	
1 1 1 0 1 1 1 1	SNA-Specific PI Extension, x'80'
1 1 1 1 0 0 0 0	
. . . . .	- Reserved
1 1 1 1 1 1 1 0	
1 1 1 1 1 1 1 1	SNA-Specific PI Extension, x'80'

Unassigned values are reserved - SNA-to-non_SNA

Figure 9-3. SNA-Specific Protocol Identifier Values

Bit Pattern 8 7 6 5 4 3 2 1	SNA/X.25 Protocol Identifier Extension (CUD octet 3)
0 0 0 0 0 0 0 0	
. . . . . .	Reserved
1 1 1 1 1 1 1 0	
1 1 1 1 1 1 1 1	- Reserved for SNA-specific Extension

Figure 9-4. SNA-Specific Extended Protocol Identifier Values

9.4.2 Priority

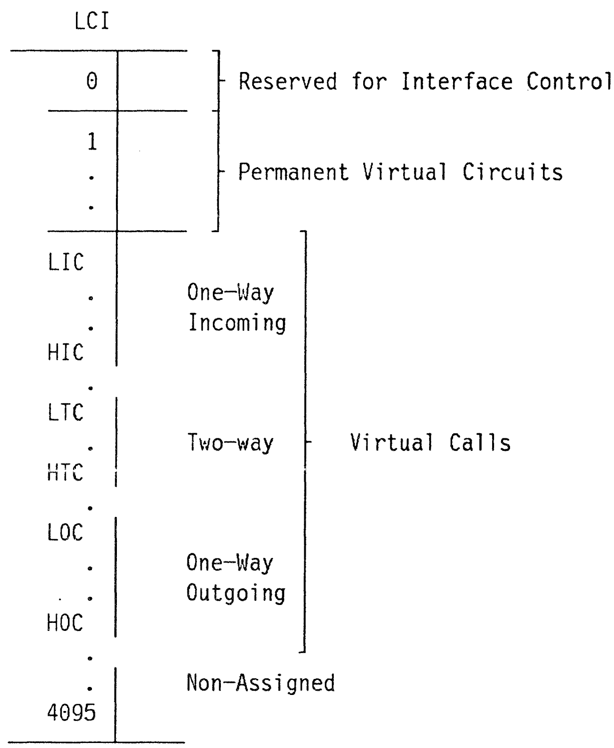
Support of Open System Interconnection (OSI) requires that the CCITT_Specified_DTE_Facility Priority Facility (see "Priority_Facility" on page G-7) be supported.

Appendixes

Appendix A. Logical Channel Ranges

Logical channel number one (1) is used by IBM SNA X.25 DTEs that support a single logical channel.

For each multiple logical channel DTE/DCE interface, a range of logical channels will be agreed upon with the Administration according to Figure A-1.



LCI = Logical Channel Identifier
LIC = Lowest Incoming Channel
HIC = Highest Incoming Channel
LTC = Lowest Two-Way Channel
HTC = Highest Two-Way Channel
LOC = Lowest Outgoing Channel
HOC = Highest Outgoing Channel

Figure A-1. Logical Channel Assignments

Logical channel '0' is reserved exclusively for the transmission of RESTART, DIAGNOSTIC, and REGISTRATION packets.

LCI:

= 1 to LIC-1 is the range of logical channels assigned for permanent virtual circuits.

= LIC to HIC is the range of logical channels which are assigned to one-way incoming logical channels for virtual calls (see "One-Way Logical Channel Incoming").

= LTC to HTC is the range of logical channels which are assigned to two-way logical channels for virtual calls.

= LOC to HOC is the range of logical channels which are assigned to one-way outgoing logical channels for virtual calls (see "One-Way Logical Channel Outgoing").

= HIC + 1 to LTC - 1, HTC + 1 to LOC - 1, and HOC+1 to 4095 are non-assigned logical channels.

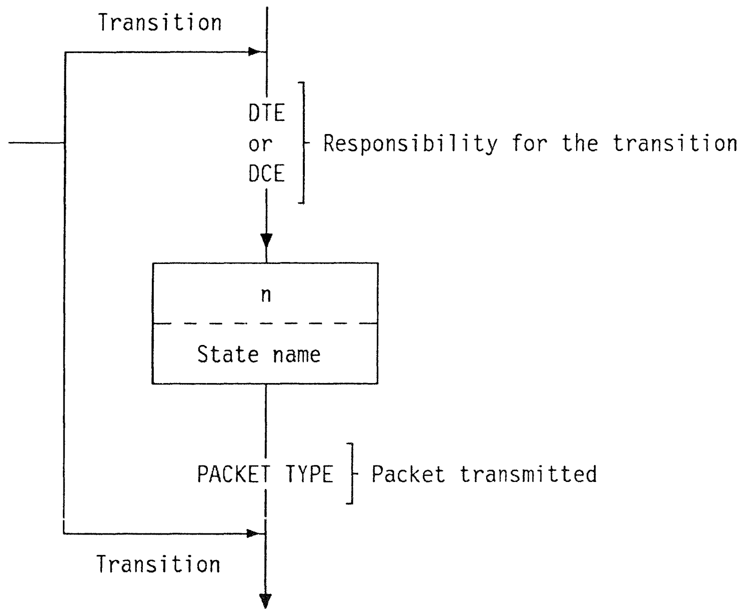
With reference to Figure A-1 on page A-1:

Notes:

1. The reference to the number of logical channels is made according to a set of contiguous numbers from 0 (lowest) to 4095 (highest) using 12 bits made up of the 4 bits of the Logical Channel Group Number (see §-5.1.2) and the 8 bits of the Logical Channel Number (see §-5.1.3). The numbering is binary coded using bit positions 4 through 1 of octet one followed by bit positions 8 through 1 of octet two with bit 1 of octet two being the low order bit.
2. All logical channel boundaries are agreed upon with the Administration for a period of time.
3. To avoid frequent rearrangement of logical channels, not all logical channels within the range allocated for permanent virtual circuits are necessarily assigned.
4. In the absence of permanent virtual circuits, logical channel 1 is available for LIC. In the absence of permanent virtual circuits and one-way incoming logical channels, logical channel 1 is available for LTC. In the absence of permanent virtual circuits, one-way incoming logical channels and two-way logical channels, logical channel 1 is available for LOC.
5. The DCE search algorithm for a logical channel for a new incoming call will be to use the lowest logical channel in the Ready state in the range LIC to HIC and LTC to HTC.
6. In order to minimize the risk of call collision, the DTE search algorithm is suggested to start with the highest numbered logical channel in the READY state. The DTE could start with the two-way logical channel or one-way outgoing logical channel ranges.

Appendix B. Packet Layer DTE/DCE Interface State Diagrams

B.1 Symbol definition of the state diagram



With reference to the symbol definition:

Notes:

1. States are represented by boxes wherein the state name and number are indicated.
2. State transitions are represented by lines with arrows. The station (DTE or DCE) responsible for the transition and the packet transferred (if any) is indicated in the transition lines.

B.2 Order Definition of the State Diagrams

For the sake of clarity, the normal procedure at the interface is described in a number of small state diagrams. In order to describe the normal procedure fully, it is necessary to allocate a priority to the different figures and to relate a higher order diagram with a lower one. This is done by the following means:

- The figures are arranged in order of priority with Figure B-1 on page B-2 (Restart) having the highest priority and subsequent figures having lower priority. Priority means that when a packet belonging to a higher order diagram is transferred, that diagram is applicable and the lower order one is not.
- The relation with a state in a lower order diagram is given by including that state inside a box in the higher order diagram.

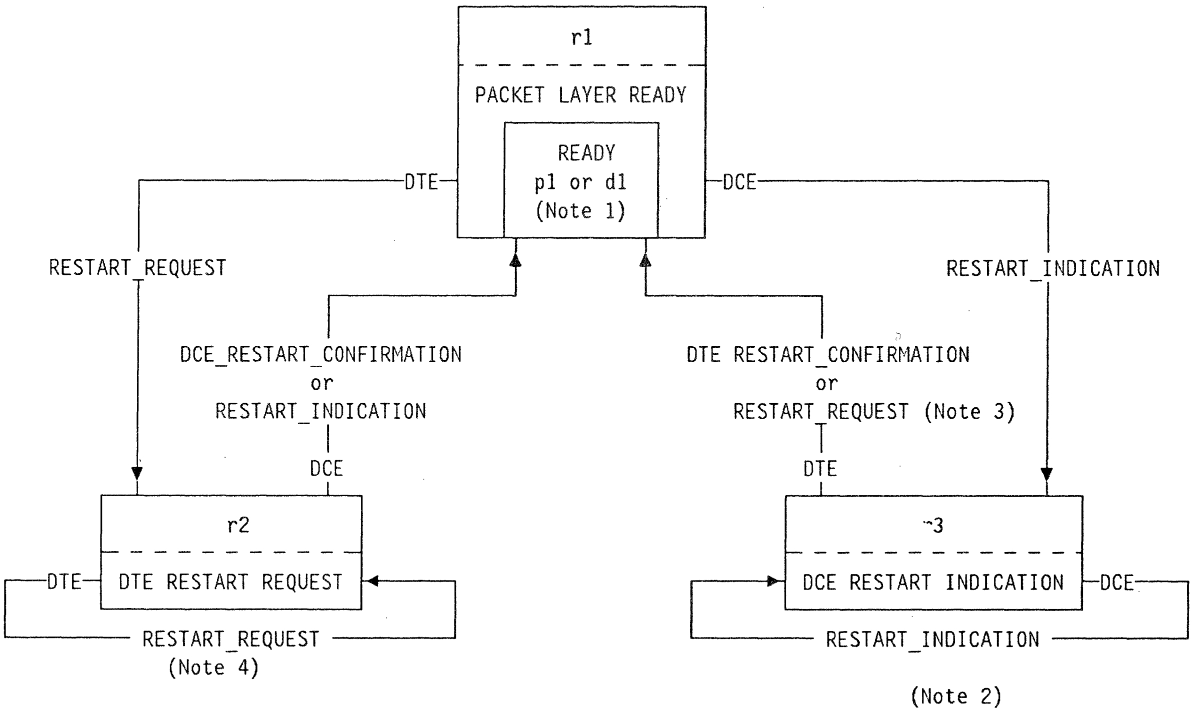


Figure B-1. Diagram of States for the Transfer of RESTART Packets

With reference to Figure B-1:

Notes:

1. State p1 is for virtual calls and state d1 is for permanent virtual circuits.
2. This transition may take place after time-out T10.
3. This transition also takes place after timeout T10 expires the second time without transmission of any packet except, possibly, a diagnostic packet.
4. This transition may take place after a 200 second time-out.
5. In a DTE/DTE environment, DCE in this diagram will be replaced by DTE.

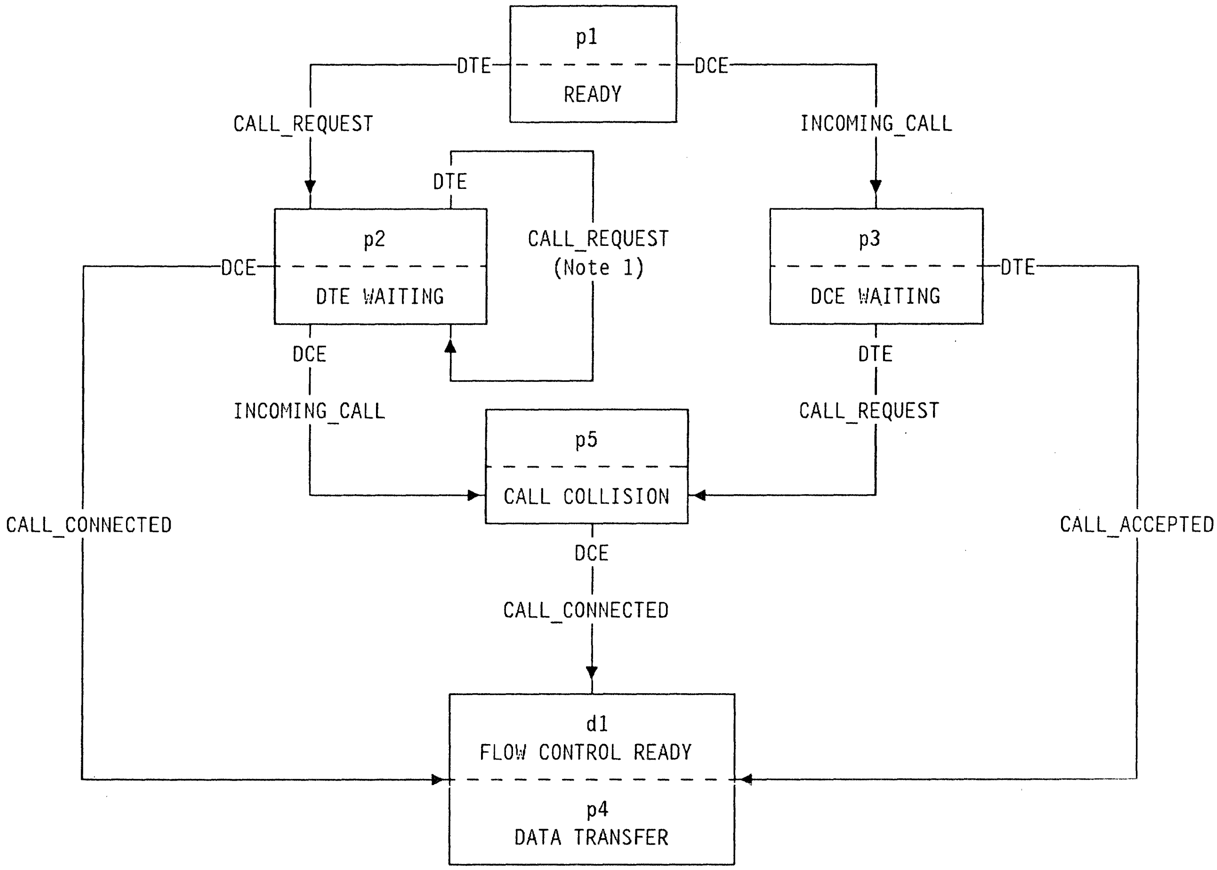


Figure B-2. Diagram of States for the Transfer of Call Set-Up Packets within the Packet Level Ready State

Notes:

1. This transition may take place after a 200 second time-out.
2. In a DTE/DTE environment, DCE in this diagram will be replaced by DTE.

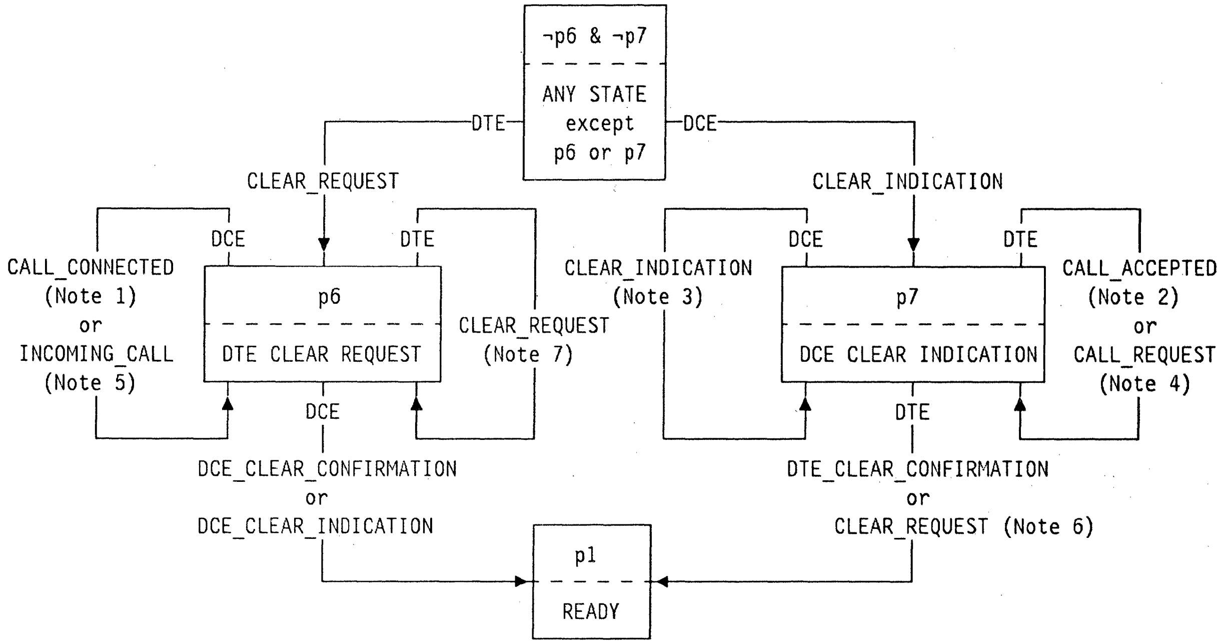


Figure B-3. Diagram of States for the Transfer of Call Clearing Packets

With reference to Figure B-3:

Notes:

1. This transition is possible only if the previous state was DTE Waiting (p2).
2. This transition is possible only if the previous state was DCE Waiting (p3).
3. > This transition takes place after Time-out T13 expires the first time.
4. This transition is possible only if the previous state was Ready (p1) or DCE Waiting (p3).
5. This transition is possible only if the previous state was Ready (p1) or DTE_Waiting (p2).
6. > This transition takes place after timeout T13 expires the second time
   > without transmission of any packet except, possibly a diagnostic packet.
7. This transition may take place after a 200 second time-out.
8. + In a DTE/DTE environment, DCE in this diagram will be replaced by DTE.

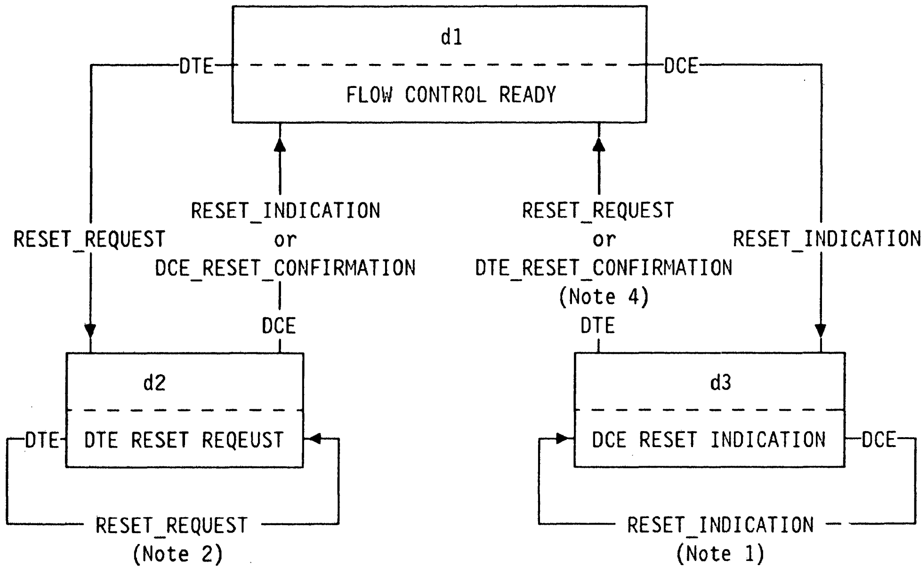


Figure B-4. Diagram of States for the Transfer of Reset packets in Data Transfer (p4) State

With reference to Figure B-4:

Notes:

> 1. This transition takes place after time-out T12 expires the first time.
2. This transition may take place after a 200 second time-out.

\+ 3. In a DTE/DTE environment, DCE in this diagram will be replaced by DTE.

\+ 4. For permanent virtual circuits, DCE enters the d1 state and may issue a
\+ DIAGNOSTIC packet (#51) after timer T12 expires the second time.

Appendix C. Packet Layer DCE Actions

Actions taken by the DCE on Receipt of Packets in a given State of the Packet Layer DTE/DCE Interface as perceived by the DCE.

C.1 Introduction

This appendix specifies the actions taken by the DCE on receipt of packets in a given state of the packet layer DTE/DCE interface as perceived by the DCE. It is presented as a succession of chained tables. The following rules are valid for all these tables:

- There may be more than one error associated with a packet. The network will stop normal processing of a packet when an error is encountered. Thus only one diagnostic code is associated with an error indication by the DCE. The order of packet decoding and checking on networks is not standardized.
- For those networks which are octet aligned, the detection of a non-integral number of octets may be made at the data link or packet layer. In this appendix, only those networks which are octet aligned and detect the non-integral number of octets at the packet layer are concerned with the considerations about octet alignment.
- In each table, the actions taken by the DCE are indicated in the following way:
  - DISCARD: the DCE discards the received packet and takes no subsequent action as a direct result of receiving that packet; the DCE remains in the same state.
  - DIAG #x: the DCE discards the received packet and, for networks that implement the diagnostic packet, transmits to the DTE a DIAGNOSTIC packet containing the diagnostic code #x. The state of the interface is not changed.
  - NORMAL or ERROR: the corresponding action is specified after each table.
- Appendix E, "Network Generated Diagnostic Codes" gives a list of the Diagnostic_Codes which may be used.

C.2 DCE State/Action Tables

Table C_1: Special Cases	
Packet from the DTE	Any State
Any packet with packet length shorter than 2 octets. Including link layer valid I-frame containing no packet.	DIAG #38
Any packet with invalid General Format Identifier (GFI)	DIAG #40
Any packet with unassigned logical channel	DIAG #36
Any packet with correct GFI and assigned logical channel, or with correct GFI and LCI = x'000'	See Table C_2

Table C_2: Actions taken by the DCE on Receipt of Packets in a Given State of the Packet Layer DTE/DCE Interface as Perceived by the DCE: RESTART and REGISTRATION Procedures

State of the interface as perceived by the DCE / Packet Received from the DTE	PACKET LAYER READY r1	DTE RESTART REQUEST r2	DCE RESTART INDICATION r3
RESTART_REQUEST with LCI = x'000'	NORMAL (r2)	DISCARD	NORMAL (r1)
DTE_RESTART_CONFIRMATION with LCI = x'000'	ERROR (r3) # 17	ERROR (r3) # 18	NORMAL (r1)
REGISTRATION REQUEST (when supported by the DCE) with LCI = x'000'	NORMAL (r1)	NORMAL (r2)	NORMAL (r3)
Packet supported by the DCE other than RESTART REQUEST, DTE RESTART CONFIRMATION and REGISTRATION REQUEST (when supported by the DCE) with LCI = x'000'	DIAG # 36	DIAG # 36	DIAG # 36
Packet having a Packet Type Identifier which is shorter than 1 octet with LCI = x'000'	DIAG # 38	ERROR (r3) #38	DISCARD
Packet having a Packet Type Identifier which is undefined or not supported by the DCE (i.e., REJECT or REGISTRATION) with LCI = x'000'	DIAG # 33	ERROR (r3) #33	DISCARD
DATA, [INTERRUPT], CALL SET-UP and CLEARING, FLOW_CONTROL or RESET with assigned logical channel	See Table C_3 or C_4 (Note)	ERROR (r3) #18	DISCARD
RESTART_REQUEST, DTE_RESTART_CONFIRMATION or REGISTRATION_REQUEST (when supported by the network) with LCI not = x'000'	See Table C_3 or C_4 (Note)	ERROR (r3) #41	DISCARD
Packet having a Packet Type Identifier which is shorter than 1 octet with assigned logical channel	See Table C_3 or C_4 (Note)	ERROR (r3) #38	DISCARD
Packet having a Packet Type Identifier which is undefined or not supported by the DCE (i.e., REJECT or REGISTRATION packet) with assigned logical channel	See Table C_3 or C_4	ERROR (r3) #33	DISCARD

With reference to Table C_2:

Note:

Table C_3 for logical channels assigned to virtual calls, Table C_4 for logical channels assigned to permanent virtual circuits.

ERROR (r3), #x:

The DCE discards the received packet, indicates a restarting by transmitting to the DTE a RESTART_INDICATION packet, with the Cause "Local_Procedure_Error" and the Diagnostic #x, and enters state r3. If connected through a virtual call, (all) distant DTE(s) are also informed of the restarting by a CLEAR_INDICATION packet, with the Cause "Remote_Procedure_Error" (same Diagnostic). In the case of a permanent virtual circuit, (all) distant DTE(s) will be informed by a RESET_INDICATION packet, with the Cause "Remote_Procedure_Error" (same Diagnostic).

NORMAL (ri):

Provided none of the following error conditions have occurred, the action taken by the DCE follows the procedure defined in §§ 3 and 6.1, and the DTE/DCE interface enters state ri:

- If a RESTART_REQUEST packet or DTE_RESTART_CONFIRMATION packet received in state r3, or a REGISTRATION_REQUEST packet received in state r2 or r3, exceeds the maximum permitted length, is too short or is not octet aligned (see rule 2 in the introduction of this appendix), the DCE will invoke the ERROR #39, #38 or #82 procedure, respectively.

  Note: In the case of a REGISTRATION_REQUEST packet received in state r2 or r3 with the error(s) as noted above, alternative behavior by the DCE is for further study.

  Some networks may invoke the ERROR #81 procedure if the restarting cause field is not "DTE_Originated" in the RESTART_REQUEST packet received in state r3.

- If a RESTART_REQUEST or a REGISTRATION_REQUEST packet received in state r1 exceeds the maximum permitted length, is too short or is not octet aligned (see rule 2 in the introduction to this appendix), the DCE shall invoke the DIAG #39, #38 or #82 procedure, respectively.

  Some networks may invoke the DIAG #81 procedure if the restarting cause field is not "DTE_Originated" in the RESTART_REQUEST packet received in state r1.

- If a REGISTRATION_REQUEST packet is received from the DTE when the On-Line_Facility_Registration facility is supported by the DCE but not subscribed by the DTE, the DCE shall transmit to the DTE a REGISTRATION_CONFIRMATION packet with the Cause "Local_Procedure_Error," the Diagnostic #42, and no Registration field.

If a REGISTRATION_REQUEST packet modifying one or more of the facilities which can take effect only when all logical channels used for virtual calls are in state p1 (Appendix F, "On-Line Registration Facility Applicability") is received when it is possible to make modification, the DCE shall transmit a RESTART_INDICATION packet with the Cause "Registration/Cancellation_Confirmed" and Diagnostic #0 and enter state r3, if there is one or more logical channel assigned to permanent virtual circuits. This action ensures that the permanent virtual circuits are reset so that all of the negotiated facilities can properly take effect.

Table C_3: Actions taken by the DCE on Receipt of Packets in a Given State of the Packet Layer DTE/DCE Interface as Perceived by the DCE: CALL SET-UP and CLEARING on Logical Channels Assigned to Virtual Call (see Note 1)

Interface States Perceived by the DCE / Packet on assigned LCI	PACKET LAYER READY r1						
	READY p1	DTE WAITING p2 Note 3	DCE WAITING p3 Note 2	DATA TRANSFER p4	CALL COLLISON p5 Note 2,3	DTE CLEAR REQUEST p6	DCE CLEAR INDICATION p7
CRQ	NORMAL (p2)	ERROR (p7) #21	NORMAL (p5)	ERROR (p7) #23	ERROR (p7) #24	ERROR (p7) #25	DISCARD (p7)
CAC	ERROR (p7) #20	ERROR (p7) #21	NORMAL (p4)	ERROR (p7) #23	ERROR (p7) #24	ERROR (p7) #25	DISCARD (p7)
CLR	NORMAL (p6)	NORMAL (p6)	NORMAL (p6)	NORMAL (p6)	NORMAL (p6)	DISCARD (p6)	NORMAL (p1)
TCC	ERROR (p7) #20	ERROR (p7) #21	ERROR (p7) #22	ERROR (p7) #23	ERROR (p7) #24	ERROR (p7) #25	NORMAL (p1)
DIR|FC	ERROR (p7) #20	ERROR (p7) #21	ERROR (p7) #22	See Table C_4	ERROR (p7) #24	ERROR (p7) #25	DISCARD (p7)
IRR,TIR or RGR w/LCI≠0	ERROR (p7) #41	ERROR (p7) #41	ERROR (p7) #41	See Table C_4	ERROR (p7) #41	ERROR (p7) #41	DISCARD (p7)
UNK	ERROR (p7) #38	ERROR (p7) #38	ERROR (p7) #38	See Table C_4	ERROR (p7) #38	ERROR (p7) #38	DISCARD (p7)
NUP	ERROR (p7) #33	ERROR (p7) #33	ERROR (p7) #33	See Table C_4	ERROR (p7) #33	ERROR (p7) #33	DISCARD (p7)

CRQ: CALL_REQUEST   CAC: CALL_ACCEPTED   CLR: CLEAR_REQUEST
TCC: DTE_CLEAR_CONFIRMATION   DIR|FC: DATA, INTERRUPT, RESET or Flow_Control
RGR: REGISTARTION_REQUEST
IRR|TIR: RESTART_REQUEST or DTE_RESTART_CONFIRMATION
UNK: Packet having a PTI shorter than one octet
NUP: Packet having a PTI which is Undefined or Not Supported by the DCE
LCI: Logical Channel Identifier

With reference to Table C_3:

Notes:

1. On permanent virtual circuits, only state p4 exists and the DCE takes no action except those specified in Table C_4.
2. This state does not exist in the case of an outgoing one-way logical channel (as perceived by the DTE).
3. This state does not exist in the case of an incoming one-way logical channel (as perceived by the DTE).

ERROR (p7), #x:

The DCE discards the received packet, indicates a clearing by transmitting to the DTE a CLEAR_INDICATION packet, with the Cause "Local_Procedure_Error" and the Diagnostic #x, and enters state p7. If connected through a virtual call, the remote DTE is informed of the clearing by a CLEAR_INDICATION packet, with the Cause "Remote_Procedure_Error" (same diagnostic).

NORMAL (pi):

Provided none of the following error conditions have occurred, the action taken by the DCE follows the procedures defined in § 4 and the DTE/DCE interface enters state pi. In all the cases specified under, the DCE will transmit to the DTE a CLEAR_INDICATION with the appropriate Cause and Diagnostic, and enter state p7. If connected through a virtual call, the distant DTE is also informed of the clearing by a CLEAR_INDICATION packet with the Cause "Remote_Procedure_Error" (same Diagnostic).

A) CALL_REQUEST packet		Specific Diagnostic
Error Condition	Cause	
1. Packet not octet aligned	Local_Procedure_Error	#82
2. Packet too short	Local_Procedure_Error	#38
3. Incoming one-way logical channel (as perceived by DTE)	Local_Procedure_Error	#34
4. Address length larger than remainder of packet	Local_Procedure_Error	#38
5. Address contains a non-BCD digit	Local_Procedure_Error	#67|68
6. Invalid calling DTE address (see Note 1)	Local_Procedure_Error	#68
7. Invalid Called DTE address (see Note 1)	Local_Procedure_Error	#67
Note 1: Possible reasons for invalid address include: - Prefix digit not supported, - Invalid type of address/numbering plan identification informations (A bit set to 0) - National address smaller than national address format permits, - National address larger than national address format permits, - DNIC less than four digits, etc.		
8. Value of the facility length field greater than 109	Local_Procedure_Error	#69
9. No combination of facilities could equal facility length	Local_Procedure_Error	#69
10. Facility length larger than remainder of packet	Local_Procedure_Error	#38
11. Facility Code not allowed	Invalid_Facility_Req.	#65
12. Facility value not allowed or invalid	Invalid_Facility_Req.	#66
13. Class coding of the facility corresponding to a length of parameter larger than remainder of packet	Local_Procedure_Error	#69
14. Facility code repeated	Local_Procedure_Error	#73
15. Invalid network user identification	Invalid_Facility_Req.	#84
16. NUI_Selection facility expected by the DCE and not provided by the DTE	Local_Procedure_Error	#84
17. Invalid/unsupported NUI value or missing NUI detected at inter-network interface	Access_Barred	#84
18. RPOA Selection required provided by the DTE	RPOA_Out_Of_Order	#76

A) CALL_REQUEST Packet (Continued)		Specific Diagnostic
Error Condition	Cause	
19. Facility value conflict (e.g., combination not supported	Invalid_Facility_Req.	#66
20. CCITT-specified DTE facility code or parameter not allowed or invalid	Invalid_Facility_Req.	#77
21. Call_User_Data larger than 16 octets (or 128 octets for Fast-Select)	Local_Procedure_Error	#39
If the virtual call cannot be established by the network, the DCE should use a Call_Progress signal and Diagnostic_Code among the following:		
22. Requested_RPOA_Out_Of_Order	RPOA_Out-of-Order	# 0
23. Requested RPOA invalid or not supported	RPOA_Out_Of_Order	#119
24. Unknown number	Not_Obtainable	#67
25. Incoming call barred	Access_Barred	#70
26. Closed user group protection	Access_Barred	#65
27. Ship absent	Ship_Absent	# 0
28. Reverse_Charging rejected	Reverse_Charging_ Acceptance not subscribed	# 0
29. Fast_Select rejected	Fast_Select_Acceptance not subscribed	# 0
30. Called DTE out-of-order	Out-of-Order	#0|>127
31. No logical channel available	Number_Busy	#71
32. Call collision	Number_Busy	#71|72
33. The remote DTE/DCE interface or the transit network does not support a function or a facility requested	Incompatible_Destination	# 0
Note: Precise definition of error condition 30 necessitates further study and should take into account the possible non-support of the virtual call service (only permanent virtual circuit) by the destination DTE.		
34. Procedure error at the remote DTE/DCE interface	Remote_Procedure_Error	(see b and c) below & Appendix D
35. Temporary network congestion or fault condition within the network	Network_Congestion	# 0, 122 or >127

B) CALL_ACCEPTED Packet

Error Condition	Cause	Specific Diagnostic
1. Packet not octet aligned	Local_Procedure_Error	#82
2. Address length larger than remainder of packet	Local_Procedure_Error	#38
3. Address contains a non-BCD digit	Local_Procedure_Error	#67|68
4. Invalid calling DTE Address (see Note 1 under A)	Local_Procedure_Error	#68
5. Invalid called DTE Address (see Note 1 under A)	Local_Procedure_Error	#67
6. Value of the facility length field greater than 109	Local_Procedure_Error	#69
7. No combination of facilities could equal facility length	Local_Procedure_Error	#69
8. Facility length larger than remainder of packet	Local_Procedure_Error	#38
9. Facility_Code not allowed	Invalid_Facility_Req.	#65
10. Facility_Value not allowed or invalid	Invalid_Facility_Req.	#66
11. Class coding of the facility corresponding to a length of parameter field larger than remainder of packet	Local_Procedure_Error	#69
12. Facility_Code repeated	Local_Procedure_Error	#73
13. Invalid network user identification	Invalid_Facility_Req.	#84
14. NUI_Selection facility expected by the DCE and not provided by the DTE	Local_Procedure_Error	#84
15. Invalid/unsupported NUI value or missing NUI detected at inter-network interface	Access barred	#84
16. Facility_Value conflict (e.g., combination not supported)	Invalid_Facility_Req.	#66
17. CCITT-specified DTE facility code or parameter not not allowed or invalid	Invalid_Facility_Req.	#77
18. Call user data larger than 128 (if Fast_Select facility requested)	Local_Procedure_Error	#39
19. Call user data present (if Fast_Select facility not requested)	Local_Procedure_Error	#39
20. The INCOMING_CALL packet indicated Fast_Select with restriction on response	Local_Procedure_Error	#42

Some networks invoke the ERROR #74 procedure if the address length fields are not equal to '0' in the CALL_ACCEPTED packet, except when the Called_Line_Modified_Notification facility is present in the facility field.
However, this violates American National Standards Institute ANS X3.100 and is not recommended.

C) CLEAR_REQUEST Packet		Specific Diagnostic
Error Condition	**Cause**	
1. Packet not octet aligned	Local_Procedure_Error	#82
2. Packet too short	Local_Procedure_Error	#38
3. Packet length incorrectly larger than 5 octets	Local_Procedure_Error	#39
4. Calling DTE address length ≠0 (at any time); called DTE address length ≠0 except when the Called_Line_Address_ Modified_Notification facility is present in clearing a call in p3.	Local_Procedure_Error	#74
5. Invalid called DTE address when the Called_Line_Address_ Modified_Notification facility is present in clearing a call in state p3 (see Note 1 under A)	Local_Procedure_Error	#67
6. Value of the facility length field greater than 109	Local_Procedure_Error	#69
7. No combination of facilities could equal facility length	Local_Procedure_Error	#69
8. Facility length larger than remainder of packet	Local_Procedure_Error	#38
9. Facility_Code not allowed	Invalid_Facility_Req.	#65
10. Facility_Value not allowed or invalid	Invalid_Facility_Req.	#66
11. Class coding of the facility corresponding to a length of parameter field larger than remainder of packet	Local_Procedure_Error	#69
12. Facility_Code repeated	Local_Procedure_Error	#73
13. Call_Deflection_Selection facility requested when the maximum number of call redirections and call deflections is reached	Invalid_Facility_Req.	#78
14. Call_Deflection_Selection facility requested after timer expiration	Invalid_Facility_Req.	#53
15. Clear_User_Data larger than 128 (if Fast_Select facility requested)	Local_Procedure_Error	#39
16. Clear_User_Data present (if Fast_Select facility and Call_Deflection facility not requested)	Local_Procedure_Error	#39
17. Clear_User_Data larger than 16 (if Fast_Select facility requested)	Local_Procedure_Error	#39
Some networks invoke the ERROR #81 procedure if the Clearing_Cause field is not "DTE_Originated" in the CLEAR_REQUEST packet.		

D) DTE_CLEAR_CONFIRMATION Packet		Specific Diagnostic
Error Condition	**Cause**	
1. Packet not octet aligned	Local_Procedure_Error	#82
2. Packet length greater than 3 octets	Local_Procedure_Error	#39

TABLE C_4: Actions taken by the DCE on Receipt of Packets in a given State of the Packet Layer DTE/DCE Interface as Perceived by the DCE: Data Transfer (Flow Control and Reset) on Assigned Logical Channels			
State of the interface as perceived by the DCE Packet from the DTE with assigned logical channel	DATA TRANSFER p4		
	Flow_Control_ Ready d1	DTE_Reset_ Request d2	DCE Reset_ Indication d3
RESET_REQUEST	NORMAL (d2)	DISCARD	NORMAL (d1)
DTE_RESET_CONFIRMATION	ERROR (d3) #27	ERROR (d3) #28	NORMAL (d1)
DATA, [INTERRUPT] OR FLOW CONTROL	NORMAL (d1)	ERROR (d3) #28	DISCARD
RESTART_REQUEST, DTE RESTART_CONFIRMATION or or REGISTRATION with LCI ¬=x'000'	ERROR (d3) #41	ERROR (d3) #41	DISCARD
Packet having a PTI which is shorter than '1' octet	ERROR (d3) #38	ERROR (d3) #38	DISCARD
Packet having a PTI which is undefined or not supported (i.e., REJECT or REGISTRATION)	ERROR (d3) #33	ERROR (d3) #33	DISCARD
Invalid packet type on a PVC	ERROR (d3) #35	ERROR (d3) #35	DISCARD
REJECT PACKET NOT SUBSCRIBED	ERROR (d3) #37	ERROR (d3) #37	DISCARD

With reference to Table C_4:

ERROR (r3), #x:

The DCE discards the received packet, indicates a reset by transmitting to the DTE a RESET_INDICATION packet, with the Cause "Local_Procedure_Error" and the Diagnostic #x, and enters state d3. The distant DTE is also informed of the reset a RESET_INDICATION packet, with the Cause "Remote_Procedure_Error" (same Diagnostic).

NORMAL (di):

Provided none of the following error conditions or special situations have occurred, the actions taken by the DCE follows the procedure defined in § 4:

- If the packet exceeds the maximum permitted length, is too short, or is not octet aligned, (see rule 2 in the introduction to this Appendix), the DCE will invoke the ERROR #39, #38 or #82 procedure, respectively.

- Some networks may invoke the ERROR #81 procedure if the resetting Cause field in the RESET_REQUEST packet does not have the value "DTE_Originated."
- Some networks may invoke the ERROR #83 procedure if Q-bit is not the same value within a complete packet sequence.
- If the Ps or Pr received is not valid, the DCE will invoke the ERROR #1 or #2 procedure, respectively.
- The DCE will consider the receipt of a DTE_INTERRUPT_CONFIRMATION packet which does not correspond to a yet unconfirmed DCE_INTERRUPT packet as an error and will invoke the ERROR #43 procedure. The DCE will consider a DTE_INTERRUPT packet received before a previous DTE_INTERRUPT packet has been confirmed as an error, and will invoke the ERROR #44 procedure.
- If the network has a temporary inability to handle data traffic for a permanent virtual circuit (see § 4.2), and if the packet is a DATA, INTERRUPT, Flow_Control or RESET_REQUEST packet received in state d1, the DCE shall transmit to the DTE a RESET_INDICATION packet with the Cause "Network_Out-of-Order" and enter state d3 (DATA, INTERRUPT or Flow_Control packet) or d1 (RESET_REQUEST packet).

Appendix D. DCE Time-outs and DTE Time-limits

Packet Layer DCE Time-outs and DTE Time-limits.

D.1 DCE Time-Outs

Under certain circumstances, this specification requires the DTE to respond to a packet issued from the DCE within a stated maximum time.

Table D_1 covers these circumstances and the actions that DCE will initiate upon expiration of that time.

The time-out values used by the DCE will never be less than those indicated in Table D_1.

D.2 DTE Time-Limits

Under certain circumstances, this specification requires the DCE to respond to a packet from the DTE within a stated maximum time. The actual DCE response times should be well within the specified time-limits. The rare situation where a time-limit is exceeded should only occur when there is a fault condition.

To facilitate recovery from such fault conditions, IBM SNA X.25 DTEs incorporate timers. The time-limits given in Table D_2 are the lower limits of the times a DTE should allow for proper operation. A time-limit longer than the values shown may be used. Suggestions on possible DTE actions upon expiration of the time-limits are given in Table D_2.

Note:

A DTE may use a time shorter than the value given for T21 in Table D_2. This may be appropriate when the DTE knows the normal response time of the called DTE to an incoming call. In this case, the timer should account for the normal maximum response time of the called DTE and the estimated maximum call set-up time.

Table D_1: DCE_Time-Outs					Actions taken when the Time-out expires			
Time-Out		LC State	Starts When	Normally Terminated When	Local Side		Remote Side	
No.	Value				1st Time	2nd Time	1st Time	2nd Time
T10	60 secs.	r3	DCE sends RESTART INDICATION	DCE leaves state r3 (i.e., RESTART CONFIRM. or RESTART REQ. rcvd)	See 1a1 below	See 1a2 below	See 1b1 below	See 1b2 below
T11	180 secs.	p3	DCE sends INCOMING CALL	DCE leaves state p3 (e.g., CLEAR REQ., CALL ACC. or CALL REQ. rcvd)	See 2a1 below	See 2a2 below	See 2b1 below	See 2b2 below
T12	60 secs.	d3	DCE sends RESET INDICATION	DCE leaves state d3 (e.g., RESET CONFIRM. or RESET REQUEST received)	See 3a1 below	See 3a2 below	See 3b1 below	See 3b2 below
T13	60 secs.	p7	DCE sends CLEAR INDICATION	DCE leaves state p7 (e.g., CLEAR CONFIRM. or CLEAR REQUEST received)	See 4a1 below	See 4a2 below	See 4b1 below	See 4b2 below

With reference to Table D_1:

Actions to be taken by the DCE on expiration of time-out:

1. T10:

   a. at the LOCAL DTE/DCE interface the:

      1) FIRST time it occurs:
      DCE reamins in r3, signals a RESTART_INDICATION (local procedure error #52) again, and restarts time-out T10.
      2) SECOND time it occurs:
      DCE enters the r1 state and may issue a DIAGNOSTIC packet (#52).

   b. at the REMOTE DTE/DCE interface the:

      1) FIRST time it occurs:
      For permanent virtual circuits, DCE may enter the d3 state signalling a RESET_INDICATION (remote procedure error #52).
      2) SECOND time it occurs:
      For permanent virtual circuits, DCE may enter the d3 state signalling RESET_INDICATION (remote procedure error #52).

2. T11:

   a. at the LOCAL DTE/DCE interface the:

      1) FIRST time it occurs:
      DCE enters the p7 state signalling a CLEAR_INDICATION (local procedure error #49).
      2) SECOND time it occurs:
      Not applicable.

   b. at the REMOTE DTE/DCE interface the:

      1) FIRST time it occurs:
      DCE enters the p7 state signalling a CLEAR_INDICATION (remote procedure error #49).

   2) SECOND time it occurs:
      Not applicable.

3. T12:

   a. at the LOCAL DTE/DCE interface the:

      1) FIRST time it occurs:
         DCE remains in d3, signals a RESET_INDICATION (local procedure error #51) again, and restarts time-out T12.
      2) SECOND time it occurs:
         For virtual calls, DCE enters the p7 state signalling CLEAR_INDICATION (local procedure error #51). For permanent virtual circuits, DCE enters the d1 state and may issue a DIAGNOSTIC packet (#51).

   b. at the REMOTE DTE/DCE interface the:

      1) FIRST time it occurs:
         DCE may enter the d3 state signalling a RESET_INDICATION (remote procedure error #51).
      2) SECOND time it occurs:
         For virtual calls, DCE enters the p7 state signalling a CLEAR_INDICATION (remote procedure error #51). For permanent virtual circuits, DCE may enter state the d3 state signalling a RESET_INDICATION (remote procedure error #51).

4. T13:

   a. at the LOCAL DTE/DCE interface the:

      1) FIRST time it occurs:
         DCE remains in p7 signalling a CLEAR_INDICATION (local procedure error #50) again, and restarts time-out T13.
      2) SECOND time it occurs:
         DCE enters the p1 state and may issue a DIAGNOSTIC packet (#50).

   b. at the REMOTE DTE/DCE interface the:

      1) FIRST time it occurs:
         Not applicable.
      2) SECOND time it occurs:
         Not applicable.

TABLE D_2: DTE_Time-Limits (#4)

Time-Limit No.	Time-Limit Value	LC State	Starts when	Normally Terminated when (#3)	Preferred Action to be taken when time-limit expires (#5)
T20	180 secs.	r2	DTE sends RESTART_REQ.	DTE leaves state r2 (i.e.,RESTART REQUEST or RESTART_CONFIRM. rvcd)	Retransmit the RESTART_REQUEST (#1)
T21	200 secs.	p2	DTE sends CALL_REQUEST	DTE leaves state p2 (e.g., CLEAR IND, CALL_CONN. or INC_CALL rcvd)	Transmit a CLEAR-REQUEST (#6)
T22	180 Secs.	d2	DTE sends RESET_ REQUEST	DTE leaves state d2 (e.g., the RESET_CONFIRMATION or RESET_ INDICATION is received)	For virtual calls, retransmit the RESET_REQUEST or transmit a CLEAR_REQUEST. For permanent virtual circuits, retransmit the RESET_REQUEST (#2)
T23	180 secs.	p6	DTE sends CLEAR_REQ.	DTE leaves state p6 (e.g., CLEAR CONFIRM. or CLEAR_IND. received)	Retransmit the CLEAR_REQUEST (#2)
T24 (#7)	60 Secs.	p4	DTE sends a packet with a Pr, i. e., a RR, REJECT, RNR or DATA		Transmit a RR or RNR packet (or a DATA or REJECT packet if available for transmission) reflecting the current window
T25 (#7, #8)	200 Secs.	p4	DTE sends a DATA packet or DTE's win-dow is rotat-ed but there are still outstanding DATA packets	There are no outstanding DATA packets in the window	For virtual calls, transmit a CLEAR_REQUEST. For permanent virtual circuits, transmit a RESET_REQUEST.
T26	180 Secs.	i2	DTE sends INTERRUPT	DTE receives an INTERRUPT_ CONFIRMATION	Transmit a RESET_REQUEST
T27 (#7, #8)	60 Secs.	p4	DTE sends REJECT	DTE received the first retransmitted DATA packet	Retransmit the REJECT packet & restart T27 (#9)
T28 (#3, #7, #8)	300 secs.	Any	DTE sends REGISTRATION_ REQUEST	DTE receives REGISTRATION_ CONFIRMATION or a DIAGNOSTIC packet	Retransmit the REGISTRATION_ REQUEST but should at some point recognize that the On_ Line_Facility_Registration facility is not offered

(#) - Reference to note (#).

With reference to Table D_2:

1. After unsuccessful retries, recovery decisions should be taken at higher layers.

2. After unsuccessful retries, the logical channel should be considered out-of-order. The restart procedure should only be invoked for recovery if reinitialization of all logical channels is acceptable.

3. The receipt or sending of a packet belonging to a state of higher priority will also cause the timer to normally terminate. For example, the receipt of a RESTART_INDICATION packet after having transmitted a RESET_REQUEST packet will also cause timer T22 to normally terminate.

4. Some earlier IBM SNA X.25 DTEs used 200 seconds for all timeouts.

5. When (re)transmitting a RESTART_REQUEST, CLEAR_REQUEST, or RESET_REQUEST packet, the DTE should indicate the cause as "DTE Originated." The diagnostic when T21 or T26 expires should indicate expiration of the corresponding timer. The diagnostic when any other timer expires may indicate expiration of the corresponding timer or the original error.

6. In a DTE/DTE environment, the DTE which maintains its role as a DTE for the purpose of resolving call collision should not terminate timer T21 upon receipt of an INCOMING_CALL packet.

7. T24, T25, T27, and T28 are needed only if the associated procedures are used.

8. Although the DTE starts this timer when transmitting the corresponding packet, a DCE (or DTE if DTE/DTE) is not obligated to respond to this packet in such a timely fashion so as to prevent the transmitting DTE's timer from expiring. Therefore, such a timer should be used with caution.

9. It is permissible to transmit a RESET_REQUEST packet when this timer expires (i. e., R25 and R27 are set to zero).

Table D_3: Retry Limits

Retransmission Count	Description	Default Value (2)	Action When Retransmission Count is Surpassed (Note 3)
R20 (Restart Request Retransmission Count)	Number of times a RESTART_REQUEST packet is retransmitted requesting restarting of the Packet Layer entity	1	Notify the appropriate entity
R22 (Reset Request Retransmission Count)	Number of times a RESET_REQUEST packet is retransmitted requesting resetting of the logical channel	1	For a Virtual Call, transmit a CLEAR_REQUEST packet – State p6 (Note 4) For a Permanent Virtual Circuit notify the appropriate entity
R23 (Clear Request Retransmission Count)	Number of times a CLEAR_REQUEST packet is retransmitted requesting clearing of the Virtual Call	1	Notify the appropriate entity
R25 (Data Packet Retransmission Count (Note 5)	Number of times DATA packets are retransmitted	0	Transmit a RESET REQUEST packet – State d2 (Note 4)
R27 (Reject Retransmission Count) (Note 5)	Number of times a REJECT packet is retransmitted requesting retransmission of the same DATA packet (i. e., same Pr value)	0	Transmit a RESET_REQUEST packet – State d2 (Note 4)
R28 (Registration Request Retransmission Count (Note 5)	Number of times a REGISTRATION_REQUEST is retransmitted	1	Notify the appropriate entity

With reference to Table D_3:

1. It is permissible to implement only the procedures associated with the default values.
2. With a default value of 1, the associated procedure is performed twice: once for the original transmission and once for a retransmission. To ensure proper operation because of the possibility of collisions, R20, R22, and R23 should never be set to 0.
3. If the state of the logical channel changes as a result of the action shown, then the new state is indicated.
4. When the DTE transmits a CLEAR_REQUEST or RESET_REQUEST packet, the cause indicates "DTE Originated" and the diagnostic indicates that the corresponding timer expired or retransmission count was surpassed.
5. R25, R27, and R28 are needed only if the associated procedures are used.

Appendix E. Network Generated Diagnostic Codes

Coding of X.25 Network Generated Diagnostic fields in CLEAR, RESET and RESTART_INDICATION and DIAGNOSTIC Packets.

Table E_1: DCE Diagnostics (Notes 1, 2 and 3)	HEX	Bits 8 7 6 5	Bits 4 3 2 1	Decimal
NO ADDITIONAL INFORMATION.	00	0 0 0 0	0 0 0 0	0
Invalid Ps	01	0 0 0 0	0 0 0 1	1
Invalid Pr	02	0 0 0 0	0 0 1 0	2
	..	. . . .	. . . .	. . .
	0F	0 0 0 0	1 1 1 1	15
PACKET TYPE INVALID.	10	0 0 0 1	0 0 0 0	16
For state r1	11	0 0 0 1	0 0 0 1	17
For state r2	12	0 0 0 1	0 0 1 0	18
For state r3	13	0 0 0 1	0 0 1 1	19
For state p1	14	0 0 0 1	0 1 0 0	20
For state p2	15	0 0 0 1	0 1 0 1	21
For state p3	16	0 0 0 1	0 1 1 0	22
For state p4	17	0 0 0 1	0 1 1 1	23
For state p5	18	0 0 0 1	1 0 0 0	24
For state p6	19	0 0 0 1	1 0 0 1	25
For state p7	1A	0 0 0 1	1 0 1 0	26
For state d1	1B	0 0 0 1	1 0 1 1	27
For state d2	1C	0 0 0 1	1 1 0 0	28
For state d3	1D	0 0 0 1	1 1 0 1	29
	..	. . . .	. . . .	. . .
	1F	0 0 0 1	1 1 1 1	31
PACKET NOT ALLOWED	20	0 0 1 0	0 0 0 0	32
Unidentifiable packet.	21	0 0 1 0	0 0 0 1	33
Call on one way logical channel.	22	0 0 1 0	0 0 1 0	34
Invalid packet type on a PVC	23	0 0 1 0	0 0 1 1	35
Packet on unassigned logical channel	24	0 0 1 0	0 1 0 0	36
Reject not subscribed to	25	0 0 1 0	0 1 0 1	37
Packet too short	26	0 0 1 0	0 1 1 0	38
Packet too long.	27	0 0 1 0	0 1 1 1	39
Invalid general format identifier.	28	0 0 1 0	1 0 0 0	40
Restart or Registration packet with LCI ≠ x'000' .	29	0 0 1 0	1 0 0 1	41
Packet type not compatible with facility	2A	0 0 1 0	1 0 1 0	42
Unauthorized interrupt confirmation.	2B	0 0 1 0	1 0 1 1	43
Unauthorized interrupt	2C	0 0 1 0	1 1 0 0	44
Unauthorized reject.	2D	0 0 1 0	1 1 0 1	45
	..	. . . .	. . . .	. . .
	2F	0 0 1 0	1 1 1 1	47
TIME EXPIRED	30	0 0 1 1	0 0 0 0	48
For INCOMING_CALL.	31	0 0 1 1	0 0 0 1	49
For CLEAR_INDICATION	32	0 0 1 1	0 0 1 0	50
For RESET_INDICATION	33	0 0 1 1	0 0 1 1	51
For RESTART_INDICATION	34	0 0 1 1	0 1 0 0	52
For Call Deflection.	35	0 0 1 1	0 1 0 1	53
	..	. . . .	. . . .	. . .
	3F	0 0 1 1	1 1 1 1	63

TABLE E_1: DCE Diagnostics - Continued	HEX	Bits 8 7 6 5	Bits 4 3 2 1	Decimal
CALL SETUP, CALL CLEARING or REGISTRATION PROBLEM. .	40	0 1 0 0	0 0 0 0	64
Facility/registration code not allowed	41	0 1 0 0	0 0 0 1	65
Facility/registration parameter not allowed. . . .	42	0 1 0 0	0 0 1 0	66
Invalid called address	43	0 1 0 0	0 0 1 1	67
Invalid calling address.	44	0 1 0 0	0 1 0 0	68
Invalid facility/registration length	45	0 1 0 0	0 1 0 1	69
Incoming call barred	46	0 1 0 0	0 1 1 0	70
No logical channel available	47	0 1 0 0	0 1 1 1	71
Call collision	48	0 1 0 0	1 0 0 0	72
Duplicate facility requested	49	0 1 0 0	1 0 0 1	73
Non-zero address length.	4A	0 1 0 0	1 0 1 0	74
Non-zero facility length	4B	0 1 0 0	1 0 1 1	75
Facility not provided when expected.	4C	0 1 0 0	1 1 0 0	76
Invalid CCITT-specified DTE facility	4D	0 1 0 0	1 1 0 1	77
Max # of call redirections or deflections exceeded	4E	0 1 0 0	1 1 1 0	78
	..	. . . .	. . . .	. . .
	4F	0 1 0 0	1 1 1 1	79
MISCELLANEOUS.	50	0 1 0 1	0 0 0 0	80
Improper cause code from DTE	51	0 1 0 1	0 0 0 1	81
Not aligned octet.	52	0 1 0 1	0 0 1 0	82
Inconsistent Q bit setting	53	0 1 0 1	0 0 1 1	83
NUI Problem.	54	0 1 0 1	0 1 0 0	84
	..	. . . .	. . . .	. . .
	5F	0 1 0 1	1 1 1 1	95
NON ASSIGNED	60	0 1 1 0	0 0 0 0	96
	..	. . . .	. . . .	. . .
	6F	0 1 1 0	1 1 1 1	111
INTERNATIONAL PROBLEM.	70	0 1 1 1	0 0 0 0	112
Remote network problem	71	0 1 1 1	0 0 0 1	113
International protocol problem	72	0 1 1 1	0 0 1 0	114
International link out-of-order.	73	0 1 1 1	0 0 1 1	115
International link busy.	74	0 1 1 1	0 1 0 0	116
Transit network facility problem	75	0 1 1 1	0 1 0 1	117
Remote network facility problem.	76	0 1 1 1	0 1 1 0	118
International routing problem.	77	0 1 1 1	0 1 1 1	119
Temporary routing problem.	78	0 1 1 1	1 0 0 0	120
Unknown called DNIC.	79	0 1 1 1	1 0 0 1	121
Maintenance action (see Note 4).	7A	0 1 1 1	1 0 1 0	122
	..	. . . .	. . . .	. . .
	7F	0 1 1 1	1 1 1 1	127
RESERVED FOR NETWORK SPECIFIC DIAGNOSTICS.	80	1 0 0 0	0 0 0 0	128
	..	. . . .	. . . .	. . .
	FF	1 1 1 1	1 1 1 1	255

With reference to Table E_1:

Notes:

1. Not all Diagnostic_Codes need apply to a specific network, but those used are as coded in Table E_1.

2. A given diagnostic need not apply to all packet types (i.e., RESET_INDICATION, CLEAR_INDICATION, RESTART_INDICATION, REGISTRATION_CONFIRMATION and DIAGNOSTIC packets).

3. The first diagnostic in each grouping is a generic diagnostic and can be used in place of the more specific diagnostics within the grouping. The decimal '0' Diagnostic_Code can be used in situations where no additional information is available.

4. This diagnostic may also apply to a maintenance action within a national network.

Appendix F. On-Line Registration Facility Applicability

Applicability of the On-Line_Facility_Registration facility to other facilities is summarized in Table F-1.

Table F-1: Registration Applicability	Def.	(1)	(2)	(3)
Extended_Packet_Sequence_Numbering	6.2	Y (4)	Y (4)	Y
D-Bit Modification	6.3	Y	Y	Y
Packet_Retransmission	6.4	Y	Y	Y
Incoming_Calls_Barred	6.5	Y	N	N
Outgoing_Calls_Barred	6.6	[illegible]	N	N
One-way_Logical_Channel_Outgoing	6.7	(5)	(5)	(5)
One-way_Logical_Channel_Incoming	6.8	(5)	(5)	(5)
Non-Standard_Default_Packet_Sizes	6.9	Y	Y	N
Non-Standard_Default_Window_Sizes	6.10	Y	Y	N
Default_Throughput_Classes_Assignment	6.11	Y	Y	N
Flow_Control_Parameter_Negotiation	6.12	Y	N	N
Throughput_Class_Negotiation	6.13	Y	N	N
Closed_User_Group_Related_Facilities	6.14	N	N	-
Bilateral_CUG_Related_Facilities	6.15	N	N	-
Fast_Select	6.16	N	N	-
Fast_Select_Acceptance	6.17	Y	N	N
Reverse_Charging	6.18	N	Y	-
Reverse_Charging_Acceptance	6.19	Y	Y	N
Local_Charging_Prevention	6.20	N	Y	-
NUI_Related_Facilities	6.21	N	N	-
Charging_Information	6.22			
(per interface basis)		Y	Y	N
(per call basis)		N	Y	-

Def. = Specification section where defined.
(#) = Reference to note #.

Table F-1: Registration Applicability Cont'd	Def.	(1)	(2)	(3)
RPOA_Related_Facilities				
RPOA_Subscription	6.23.1	(4)	(4)	(4)
RPOA_Selection	6.23.2	N	Y	-
Hunt_Group	6.24	N	N	-
Call_Redirection	6.25.1	(4)	(4)	(4)
Call_Deflection_Related_Facilities	6.25.2	(4)	(4)	(4)
Call_Redirection_or_Call_Deflection_ Notification	6.25.3	N	N	-
Called_Line_Address_Modified_Notification	6.26	N	N	-
Transit_Delay_Selection_and_Indication	6.27	N	Y	-
Allocation_of_Logical_Channel_Type_Ranges	A.0	Y	Y	Y

Def. = Specification section where defined.
(#) = Reference to note #.

With reference to Table F-1:

Notes:

1. Negotiable in REGISTRATION_REQUEST and REGISTRATION_CONFIRMATION packets.
2. Indication in REGISTRATION_CONFIRMATION packets whether the facility is supported by the DCE.
3. Negotiable only when every logical channel used for virtual calls is in state p1.
4. Under consideration for further study by the CCITT.
5. Negotiation of one-way logical channel ranges is accomplished by allocation of logical channel type ranges negotiation.

TABLE F-2: Packet Layer Optional User Facilities

Optional User Facility	Classification (1) VC*	PVC*	Agree For Period of Time?	Applies Per Call?	Applies to DTE/DTE Operation?
On-line_Facility_Registration	A	A	Y	N	Y (2)
Extended_Packet_Sequence_Numbering	A	A	Y	N	Y
D-bit_Modification	A	A	Y	N	N
Packet_Retransmission	A	A	Y	N	Y (2)
Incoming_Calls_Barred	E	–	Y	N	N (3)
Outgoing_Calls_Barred	E	–	Y	N	N (3)
One-way_Logical_Channel_Outgoing	E	–	Y	N	Y
One-way_Logical_Channel_Incoming	A	–	Y	N	Y
Nonstandard_Default_Packet_Sizes	A	A	Y	N	Y
Nonstandard_Default_Window_Sizes	A	A	Y	N	Y
Default_Throughput_Class_Assignment	A	A	Y	N	Y
Flow_Control_Parameter_Negotiation	E	–	Y	Y (4)	Y
Throughput_Class_Negotiation	E	–	Y	Y (4)	Y
Closed_User_Group_Related_Facilities					
-Closed_User_Group	E	–	Y	N	N
-Closed_User_Group_With_Outgoing_Access	A	–	Y	N	N
-Closed_User_Group_With_Incoming_Access	A	–	Y	N	N
-Incoming_Calls_Barred_Within_A_Closed_ User_Group	A	–	Y	N	N
-Outgoing_Calls_Barred_Within_A_Closed_ User_Group	A	–	Y	N	N
-Closed_User_Group_Selection	E	–	N	Y (4)	N
-Closed_User_Group_With_Outgoing_Access_ Selection	A	–	N	Y (4)	N
Bilateral_Closed_4ser_Group Related Facilities					
-Bilateral_Closed_User_Group	A	–	Y	N	N
-Bilateral_Closed_User_Group_With_Outgoing_ Access	A	–	Y	N	N
-Bilateral_Closed_User_Group_Selection	A	–	N	Y (4)	N
Fast_Select	E	–	N	Y	Y (5)
Fast_Select_Acceptance	E	–	Y	N	N (3)
Reverse_Charging	A	–	N	Y	N
Reverse_Charging_Acceptance	A	–	Y	N	N
Local_Charging_Prevention	A	–	Y	N	N
NUI_Subscription	A	–	Y	N	N
NUI_Override	A	–	Y	N	N
NUI_Selection	A	–	N	Y (4)	N
Charging_Information	A	–	Y	Y	N
RPOA_Subscription	A	–	Y	N	N
RPOA_Selection	A	–	N	Y	N
Hunt_Group	A	–	Y	N	N
Call_Redirection	A	–	Y	N	N
Call_Deflection_Subscription	A	–	Y	N	N
Call_Deflection_Selection	A	–	N	Y	N
Call_Redirection_or_Deflection_Notification	A	–	N	Y	N
Called_Line_Address_Modified_Notification	A	–	N	Y	N
Transit_Delay_Selection_And_Notification	E	–	N	Y	N

* VC = Virtual Call
PVC = Permanent Virtual Circuit

Notes:

1. The classification indicates whether the facility:
   - must be provided by an X.25 network (E - Essential facility),
   - may optionally be provided by an S.25 network (A - Additional facility), or
   - does not apply (shown as a dash)

   as given in CCITT Recommendation X.2.
2. In a DTE/DTE environment, use of these facilities is agreed to separately for each direction of transmission.
3. In a DTE/DTE environment, these facilities may apply only through the use of the On-line_Facility_Registration Facility.
4. These per Virtual Call facilities cannot be used unless the corresponding facility has been agreed to for a period of time.
5. In a DTE/DTE environment, use of this facility requires agreement by both DTEs for a period of time.

Appendix G. CCITT-Specified_DTE Facilities

CCITT-Specified_DTE Facilities to support the OSI.Network_Service are described in "Introduction" through "Coding of the Facility_Code Fields" on page G-3.

G.1 Introduction

The optional CCITT-Specified_DTE facilities described in this section apply only to Virtual Call service.

The facilities described in this Appendix are intended to support end-to-end signalling required by the OSI Network service. They follow the CCITT-Specified_DTE facility marker defined in § 7.1 and are applicable to both DTE/DCE and DTE/DTE operation. These facilities are passed unchanged between the two packet mode DTEs involved.

Procedures for use of these facilities by DTEs are specified below. Subsequent provision of X.25 facilities to be acted on by public data networks is for further study. Coding of the facilities in this Appendix is defined here in order to facilitate a consistent facility coding scheme in such future evolution.

G.1.1 Procedures for optional CCITT-Specified_DTE facilities

G.1.1.1 Calling_Address_Extension

Calling_Address_Extension is an optional CCITT-Specified_DTE facility which may be used for a given Virtual Call. It provides for the transparent conveyance in CALL_REQUEST and INCOMING_CALL packets of the calling OSI Network Address. The calling OSI Network Address is passed to a higher layer entity in the called DTE.

G.1.1.2 Called_Address_Extension

Called_Address_Extension is an optional CCITT-Specified_DTE facility which may be used for a given Virtual Call. It provides for the transparent conveyance in CALL_REQUEST and INCOMING_CALL packets of the called OSI Network Address supplied by a higher layer entity in the calling DTE. It also provides for the transparent conveyance of the responding OSI Network Address in CALL_ACCEPTED and CALL_CONNECTED packets (for the case of call acceptance) and in the CLEAR_REQUEST and CLEAR_INDICATION packets (for the case of call rejection). The responding OSI Network Address is passed to a higher layer entity in the calling DTE.

G.1.1.3 Minimum_Throughput_Class_Negotiation

Minimum_Throughput_Class_Negotiation is an optional CCITT-Specified_DTE facility which may be used for a given Virtual Call. The calling DTE indicates for each direction of data transmission a minimum-acceptable value for the throughput class by means of the Minimum_Throughput_Class_Negotiation Facility in the CALL_REQUEST packet. These two values are conveyed transparently to the called DTE in the INCOMING_CALL packet. Gateways, private networks, and the called DTE may clear the call if resources necessary to support the minimum-acceptable throughput classes are not available. Gateways, private networks, and the called DTE may use the

Throughput_Class_Negotiation Facility to determine whether public data networks can support the minimum-acceptable throughput classes and should clear the call if the public data network cannot support these values.

The absence of this facility indicates that the calling DTE does not place a lower limit on the acceptable throughput class. The values conveyed by this facility are supplied by a higher layer entity in the calling DTE and passed to a higher layer entity in the called DTE.

G.1.1.4 End-to-End_Transit_Delay_Negotiation

End-to-End_Transit_Delay_Negotiation is an optional CCITT_specified facility which may be used for a given Virtual Call. The calling DTE indicates the cumulative transit delay of the Packet Layer and lower layer protocols in the DTE including the effects of the access line transmission rate, by means of the End-to-End_Transit_Delay_Negotiation Facility in the CALL_REQUEST packet. The cumulative transit delay value is conveyed transparently by public data networks and is updated by gateways and the called DTE as the call setup is progressed. Gateways and the called DTE may use the Transit Delay Selection And Indication Facility introduced by the preceding network in performing the computation of the cumulative transit delay.

In addition to the cumulative transit delay, the calling DTE may optionally indicate a desired (target) value for the end-to-end transit delay. If the target value is indicated, the calling DTE may optionally indicate a maximum-acceptable value for the end-to-end transit delay. These values, when present, are provided by a higher layer entity in the calling DTE and are conveyed transparently to the called DTE in the INCOMING_CALL packet. The absence of these facilities indicates that the calling DTE did not provide a target value and/or upper limit on the transit delay.

Gateways, private networks, and the called DTE should clear the call if the cumulative transit delay exceeds the maximum-acceptable transit delay, if specified. The maximum-acceptable transit delay, when present, and the cumulative transit delay as computed by the Packet Layer of the called DTE are passed to a higher layer entity in the called DTE.

The cumulative transit delay computed by the Packet Layer of the called DTE is indicated in the CALL_ACCEPTED packet, conveyed transparently to the calling DTE in the CALL_CONNECTED packet, and passed to a higher layer entity in the calling DTE.

G.1.1.5 Priority

Priority is an optional CCITT-Specified_DTE facility which may be used for a given Virtual Call. The calling DTE may indicate in the CALL_REQUEST packet the target and lowest-acceptable values for the priority of data on a connection, priority to gain a connection, and priority to keep a connection. The values, where present, are provided by a higher layer entity in the calling DTE and are conveyed transparently by public data networks.

Gateways, private networks, and the called DTE may reduce the target values as necessary, and may clear the call if they cannot support the lowest-acceptable values. Values received by the called DTE are passed to a higher layer entity which will return selected values. These selected values are indicated by the called DTE in the CALL_ACCEPTED packet, conveyed transparently to the calling DTE in the CALL_CONNECTED packet, and passed to a higher layer entity in the calling DTE.

G.1.1.6 Protection

Protection is an optional CCITT-Specified_DTE facility which may be used for a given Virtual Call. The calling DTE may indicate in the CALL_REQUEST packet the target and lowest-acceptable values for protection. The values, where present, are provided by a higher layer entity in the calling DTE and are conveyed transparently by public data networks.

Gateways, private networks, and the called DTE may reduce the target values as necessary, and may clear the call if they cannot support the lowest-acceptable values. Values received by the called DTE are passed to a higher layer entity which will return selected values. These selected values are indicated by the called DTE in the CALL_ACCEPTED packet, conveyed transparently to the calling DTE in the CALL_CONNECTED packet, and passed to a higher layer entity in the calling DTE.

G.1.1.7 Expedited_Data_Negotiation

Expedited_Data_Negotiation is an optional CCITT-Specified_DTE facility which may be used for a given Virtual Call. The calling DTE uses the Expedited Data Negotiation Facility in the CALL_REQUEST packet to indicate whether it wishes to use the expedited data transfer procedures (i. e., the interrupt procedures). This indication is provided by a higher layer entity in the calling DTE. This facility is conveyed transparently by public data networks but may be set to non-use of the expedited data transfer procedures by gateways and private networks that do not support them.

If the higher layer entity in the called DTE wishes to use the expedited data transfer procedures and the facility received in the INCOMING_CALL packet indicates use of these procedures, then use of these procedures is indicated in the CALL_ACCEPTED packet and conveyed transparently in the CALL_CONNECTED packet. Otherwise, non-use of the expedited data transfer procedures is indicated in these packets.

The indication in the CALL_CONNECTED packet of whether use of the expedited data transfer procedures has been agreed to is passed to a higher layer entity.

G.2 Coding of the Facility_Code Fields

Table G_1 gives the coding of the Facility_Code field for each CCITT-specified_DTE facility and the packet types in which they may be present. These facilities are conveyed after the CCITT-specified_DTE Facility_Marker.

Facility	CALL REQUEST	INCOMING CALL	CALL ACCEPT.	CALL CONNECT	CLEAR REQUEST	CLEAR INDICAT	Facility Code Bits 8765 4321
Calling_Address_Extension	X	X			X*		1100 1011
Called_Address_Extension	X	X	X	X	X	X	1100 1001
Quality_of_Service_ Negotiation							
Minimum_Throughput_Class	X	X			X*		0000 1010
End-to-End_Transit_Delay	X	X	X	X	X*		1100 1010
Priority	X	X	X	X	X*		1101 0010
Protection	X	X	X	X	X*		1101 0011
Expedited_Data_Negotiation	X	X	X	X	X*		0000 1011

Table G_1: Coding of the Facility Code Field (Packet types in which it may be used)

* Only when the Call_Deflection_Selection facility is used (see § 6.25.2.2)

G.3 Coding of the Facility_Parameter Field

G.3.1 Calling_Address_Extension Facility

The octet following the Facility_Code field indicates the length of the Facility_Parameter field in octets. It has a value of n + 1, where 'n' is the number of octets necessary to hold the calling address extension. The facility parameter field follows the length and contains the calling address extension.

The first octet of the Facility_Parameter field indicates, in bits 8 and 7, the use of the calling address extension, as shown in Table G-2.

Table G-2: Coding of Bits 8 and 7 in the First Octet of the Calling Extension Facility parameter field

Bits 8 7	Use of calling address extension
0 0	To carry a calling address assigned according to CCITT Recommendation X.213/ISO 8348 AD2
0 1	Reserved
1 0	Other (to carry a calling address not assigned according to CCITT Recommendation X.213/ISO 8348 AD2
1 1	Reserved

Bits 6, 5, 4, 3, 2 and 1 of this octet indicates the number of semi-octets (up to a maximum of 40) in the calling address extension. This address length indicator is binary coded, where bit 1 is the low order bit.

The following octets contain the calling address extension.

If bits 8 and 7 of the first octet of the facility parameter field are coded '00', the following octets are encoded using the preferred binary encoding (PBE) defined in CCITT Recommendation X.213 and ISO 8348/AD2. Starting from the high-order digit of the Initial Domain Part (IDP), the address is coded in octet 2 and consecutive octets of the facility parameter field. Each digit, with padding digits applied as necessary, is coded in a semi-octet in binary coded decimal, where bit 5 or bit 1 is the low order bit of the digit. In each octet, the higher-order bit is coded in bits 8, 7, 6, and 5. The Domain Specific Part (DSP) of the calling OSI NSAP follows the IDP and is coded in decimal or binary, according to the PBE. For example, if the syntax of the DSP is decimal, each digit is coded in in binary decimal (with the same rules applying to the DSP as to the IDP above). If the syntax of the DSP is binary, each octet of the calling address extension contains an octet of the DSP.

If bits 8 and 7 of the first octet of the facility parameter field are coded '10', each digit of the calling address extension is coded in a semi-octet in binary coded decimal, where bit 5 or 1 is the low-order bit of the digit. Starting from the high-order digit, the address is coded in octet 2 and consecutive octets of the facility parameter field with two digits per octet. In each octet, the higher order digit is coded in bits 8, 7, 6, and 5. When necessary, the Facility_Parameter field shall be rounded up to an integral number of octets by inserting zeros in bits 4, 3, 2 and 1 of the last octet of the field.

G.3.2 Called_Address_Extension Facility

The octet following the Facility_Code field indicates the length of the Facility_Parameter field in octets. It has a value of n + 1, where 'n' is the number of octets necessary to hold the called address extension. The facility parameter field follows the length and indicates the called address extension.

The first octet of the Facility_Parameter indicates, in bits 8 and 7, the use of the called address extension, as shown in Table G-3.

Table G-3: Coding of Bits 8 and 7 in the First Octet of the Called Extension Facility parameter field

Bits 8 7	Use of called address extension
0 0	To carry a calling address assigned according to CCITT Recommendation X.213\ISO 8348 AD2
0 1	Reserved
1 0	Other (to carry a calling address not assigned according to CCITT Recommendation X.213/ISO 8348 AD2
1 1	Reserved

Bits 6, 5, 4, 3, 2 and 1 of this octet indicates the number of semi-octets (up to a maximum of 40) in the called address extension. This address length indicator is binary coded, where bit 1 is the low order bit.

The following octets contain the called address extension.

If bits 8 and 7 of the first octet of the facility parameter field are coded '00', the following octets are encoded using the preferred binary encoding (PBE) defined in CCITT Recommendation X.213 and ISO 8348/AD2. Starting from the high-order digit of the Initial Domain Part (IDP), the address is coded in octet 2 and consecutive octets of the facility parameter field. Each digit, with padding digits applied as necessary, is coded in a semi-octet in binary coded decimal, where bit 5 or bit 1 is the low order bit of the digit. In each octet, the higher-order bit is coded in bits 8, 7, 6, and 5. The Domain Specific Part (DSP) of the called OSI NSAP follows the IDP and is coded in decimal or binary, according to the PBE. For example, if the syntax of the DSP is decimal, each digit is coded in in binary decimal (with the same rules applying to the DSP as to the IDP above). If the syntax of the DSP is binary, each octet of the called address extension contains an octet of the DSP.

If bits 8 and 7 of the first octet of the facility parameter field are coded '10', each digit of the called address extension is coded in a semi-octet in binary coded decimal, where bit 5 or 1 is the low-order bit of the digit. Starting from the high-order digit, the address is coded in octet 2 and consecutive octets of the facility parameter field with two digits per octet. In each octet, the higher order digit is coded in bits 8, 7, 6, and 5. When necessary, the Facility_Parameter field shall be rounded up to an integral number of octets by inserting zeros in bits 4, 3, 2 and 1 of the last octet of the field.

G.3.3 Quality of Service Negotiation Facilities

G.3.3.1 Minimum_Throughput_Class Facility

The minimum throughput class for the direction of data transmission from the calling DTE is indicated in bits 4, 3, 2 and 1. The minimum throughput class for the direction of data transmission from the called DTE is indicated in bits 8, 7, 6 and 5.

The four bits indicated each throughput class are binary coded and correspond to throughput classes as indicated in Table 28.

G.3.3.2 End-to-End_Transit_Delay Facility

The octet following the Facility_Code field indicates the length in octets of the Facility_Parameter field and has the value 2, 4 or 6.

The first octet and second octets of the Facility_Parameter field contain the cumulative transit delay. The third and fourth octets are optional and, when present, contain the requested end-to-end transit delay. If the third and fourth octets are present, then the fifth and sixth octets are also optional. The fifth and sixth octets, when present, contain the maximum acceptable end-to-end transit delay. The optional octets are not present in CALL_ACCEPTED and CALL_CONNECTED packets.

Transit delay is expressed in milliseconds and is binary coded, with bit 8 of the first of a pair of octets being the high-order bit and bit 1 of the second of a pair of octets being the low-order bit. The value of all ones for cumulative transit delay indicates that the cumulative transit delay is unknown or exceeds 65,534 milliseconds.

G.3.3.3 Priority_Facility

The octet following the facility code field indicates the length in, octets, of the facility parameter field. This may take the value 1, 2, 3, 4, 5 or 6.

The first, second and third octets of the facility parameter field contain the target (CALL_REQUEST packet), available (INCOMING_CALL packet) or selected (CALL_ACCEPTED and CALL CONNECTED packets) values for the priority of data on a connection, priority to gain a connection and priority to keep a connection, respectively. The fourth, fifth and sixth octets of the facility parameter field in CALL_REQUEST and INCOMING_CALL packets contain the lowest acceptable values for the priority of data on connection, priority to gain a connection and priority to keep a connection, respectively. When the facility is present in CALL_REQUEST and INCOMING_CALL packets, octet 2 through 6 of the facility parameter field are optional. For example, if the only values to be specified are the target and lowest acceptable values for priority to gain a connection, then the facility parameter field will contain at least 5 octets with octets 1, 3 and 4 containing the value "unspecified", and octets 2 and 5 containing the specified values. When the facility is present in the CALL_ACCEPTED and CALL_CONNECTED packets, octets 2 and 4 are optional.

The range of specified values for each sub-parameter is 0 (lowest priority) to 14 (highest priority). The value 255 (x'FF' .) indicates "unspecified". All other values (i. e., 15 through 254) are reserved.

G.3.3.4 Protection_Facility

The octet following the facility code indicates the length, in octets, of the facility parameter field.

The two highest order bits of the first octet (i. e., bits 8 and 7) of the facility parameter field specify the protection format code as indicated in Table G-4.

Table G-4: Coding of the Two Highest Order Bits in the First Octet of the Protection Format Code

Bits 8 7	Protection Format Code
0 0	Reserved
0 1	Source address specific
1 0	Destination address specific
1 1	Globally unique

The remaining six bits of the octet are reserved and must be set to zero.

The second octet of the facility parameter field specifies the length 'n', in octets, of the target (CALL_REQUEST packet), available (INCOMING_CALL packet) or selected (CALL_ACCEPTED and CALL_CONNECTED packets) protection level. The actual value is placed in the following 'n' octets. Optionally, the 'n+3' octet of the facility parameter field specifies the length 'm', in octets, of the lowest acceptable protection level in CALL_REQUEST and INCOMING_CALL packets. The actual value is placed in the following 'm' octets. The optional octets are not present in CALL_ACCEPTED and CALL_ACCEPTED packets.

Note:

The values of 'n' and 'm' are bounded by both the overall length of the facility (first octet), and by each other.

G.3.4 Expedited_Data_Negotiation Facility

The coding of the Facility_Parameter field is:

```
bit 1 = 0 for no use of expedited data
      = 1 for use of expedited data
```

Note:

Bits 8, 7, 6, 5, 4, 3 and 2 may be assigned to other facilities in the future; presently, they are set to zero.

Appendix H. DTE-Generated Diagnostic Codes

Codes transferred in the Diagnostic_Code field of CLEAR, RESET AND RESTART_REQUEST packets generated IBM SNA X.25 DTEs are divided into two categories identified by the associated Cause Code. The
+ Diagnostic_Code transferred by IBM SNA X.25 DTEs when the associated
+ Cause_Code is equal to:

x'00'
: convey the CCITT/ISO-8208 Standard meaning specified in Table H_1 on SNA-to-non_SNA connections;

x'80'
: convey the SNA_Specific meaning specified in Table H_2 on SNA-to-SNA connections.

H.1 Standard CCITT X.25/ISO-8208 DTE-Generated Codes

Table H_1: CCITT/ISO-8208 Standard DTE Diagnostics	Bits 8 7 6 5 4 3 2 1	Decimal	Packet Types
No Additional Information	0 0 0 0 0 0 0 0	0	D,Rr,C,Re,Rg
Invalid P(S)	0 0 0 0 0 0 0 1	1	Re
Invalid P(R)	0 0 0 0 0 0 1 0	2	Re
	. .	.	
	0 0 0 0 1 1 1 1	15	
Packet Type Invalid	0 0 0 1 0 0 0 0	16	Rr,C,Re
for state r1	0 0 0 1 0 0 0 1	17	Rr,C,Re
for state r2	0 0 0 1 0 0 1 0	18	Rr,C,Re
for state r3	0 0 0 1 0 0 1 1	19	C
for state p1	0 0 0 1 0 1 0 0	20	C
for state p2	0 0 0 1 0 1 0 1	21	C
for state p3	0 0 0 1 0 1 1 0	22	C
for state p4	0 0 0 1 0 1 1 1	23	C
for state p5	0 0 0 1 1 0 0 0	24	C
for state p6	0 0 0 1 1 0 0 1	25	C
for state p7	0 0 0 1 1 0 1 0	26	C
for state d1	0 0 0 1 1 0 1 1	27	Re
for state d2	0 0 0 1 1 1 0 0	28	Re
for state d3	0 0 0 1 1 1 0 1	29	Re
	. .	.	
	0 0 0 1 1 1 1 1	31	
Packet Not Allowed	0 0 1 0 0 0 0 0	32	D,Rr,C,Re
unidentifiable packet	0 0 1 0 0 0 0 1	33	Rr,C,Re
call on one-way logical channel	0 0 1 0 0 0 1 0	34	C
invalid packet type on a PVC	0 0 1 0 0 0 1 1	35	Re
packet on unassigned logical channel	0 0 1 0 0 1 0 0	36	D
REJECT not subscribed to	0 0 1 0 0 1 0 1	37	Re
packet too short	0 0 1 0 0 1 1 0	38	D,Rr,C,Re,Rg
packet too long	0 0 1 0 0 1 1 1	39	D,Rr,C,RE,Rg
invalid General Format Identifier	0 0 1 0 1 0 0 0	40	D
Restart or Registration with LCI≠x'000'	0 0 1 0 1 0 0 1	41	Rr,C,Re
packet type not compatible with facility	0 0 1 0 1 0 1 0	42	C
unauthorized interrupt confirmation	0 0 1 0 1 0 1 1	43	Re
unauthorized interrupt	0 0 1 0 1 1 0 0	44	Re
unauthorized reject	0 0 1 0 1 1 0 1	45	Re
	. .	.	
	0 0 1 0 1 1 1 1	47	
Timer Expired (or Limit Surpassed)	0 0 1 1 0 0 0 0	48	D,Rr,C,Re
for INCOMING_CALL (or CALL_REQUEST)	0 0 1 1 0 0 0 1	49	C
for CLEAR_INDICATION (or REQUEST)	0 0 1 1 0 0 1 0	50	D,C
for RESET_INDICATION (or RESET_REQUEST)	0 0 1 1 0 0 1 1	51	D,C,Re
for RESTART_INDICATION (or REQUEST)	0 0 1 1 0 1 0 0	52	D,Rr,C,Re
for call deflection	0 0 1 1 0 1 0 1	53	C
	. .	.	
	0 0 1 1 1 1 1 1	63	

Table H_1: CCITT/ISO-8208 Standard DTE Diagnostics – Continued	Bits 8765 4321	Decimal	
Call Setup/Clearing or Registration Problem	0100 0000	64	C,Rg
facility/registration code not allowed	0100 0001	65	C,Rg
facility/registration parameter not allowed	0100 0010	66	C,Rg
invalid called address	0100 0011	67	C
invalid calling address	0100 0100	68	C
invalid facility/registration length	0100 0101	69	C,Rg
incoming call barred	0100 0110	70	C
no logical channel available	0100 0111	71	C
call collision	0100 1000	72	C
duplicate facility requested	0100 1001	73	C,Rg
nonzero address length	0100 1010	74	C,Rg
nonzero facility length	0100 1011	75	C
facility not provided when expected	0100 1100	76	C,Rg
invalid CCITT-Specified DTE facility	0100 1101	77	C
maximum redirections/deflections exceeded	0100 1110	78	C
	0100 1111	79	
Miscellaneous	0101 0000	80	Rr,C,Re
improper cause code from DTE	0101 0001	81	D,Rr,C,Re
non-octet aligned	0101 0010	82	D,Rr,C,Re
inconsistent Q-bit settings	0101 0011	83	Re
NUI problem	0101 0100	84	C
	. .	.	
	0101 1111	95	
Not Assigned	0110 0000	96	
	. .	.	
	0110 1111	111	
International problem	0111 0000	112	Rr,C,Re
remote network problem	0111 0001	113	C,Re
international protocol problem	0111 0010	114	C,Re
international link out of order	0111 0011	115	C,Re
international link busy	0111 0100	116	C
transit network facility problem	0111 0101	117	C
remote network facility problem	0111 0110	118	C
international routing problem	0111 0111	119	C
temporary routing problem	0111 1000	120	C
unknown called DNIC	0111 1001	121	C
maintenance action§	0111 1010	122	Rr,C,Re
	. .	.	
	0111 1111	127	
Not Assigned	1000 0000	128	
	. .	.	
	1000 1111	143	
Timer Expired (or Limit Surpassed)	1001 0000	144	Re
for INTERRUPT_CONFIRMATION	1001 0001	145	Re
for DATA packet retransmission	1001 0010	146	Re
for REJECT packet retransmission	1001 0011	147	Re
	. .	.	
	1001 1111	159	

Table H_1: CCITT/ISO-8208 Standard DTE Diagnostics - Continued	Bits	Decimal	
	8 7 6 5 4 3 2 1		
DTE-Specific Signals	1 0 1 0 0 0 0 0	160	Rr,C,Re
DTE Operational	1 0 1 0 0 0 0 1	161	Rr,Re
DTE Not operational	1 0 1 0 0 0 1 0	162	Rr,C,Re
DTE resource constraint	1 0 1 0 0 0 1 1	163	Rr,C,Re
Fast Select not subscribed	1 0 1 0 0 1 0 0	164	C
Invalid partially full DATA packet	1 0 1 0 0 1 0 1	165	Re
D-bit procedure not supported	1 0 1 0 0 1 1 0	166	C,Re
Registration/Cancellation confirmed	1 0 1 0 0 1 1 1	167	Rg
	. .	.	
	1 0 1 0 1 1 1 1	175	
Not assigned	1 0 1 1 0 0 0 0	176	
	. .	.	
	1 1 0 1 1 1 1 1	223	
OSI Network Service Problem	1 1 1 0 0 0 0 0	224	C,Re
disconnection (transient condition)	1 1 1 0 0 0 0 1	225	C
disconnection (permanent condition)	1 1 1 0 0 0 1 0	226	C
connection rejection - reason unspecified (transient condition)	1 1 1 0 0 0 1 1	227	C
connection rejection - reason unspecified (permanent condition)	1 1 1 0 0 1 0 0	228	C
connection rejection - requested quality of service not available (transient condition)	1 1 1 0 0 1 0 1	229	C
connection rejection - requested quality of service not available (permanent condition)	1 1 1 0 0 1 1 0	230	C
connection rejection - OSI network address unreachable (transient problem)	1 1 1 0 0 1 1 1	231	C
connection rejection - OSI network address unreachable (permanent problem)	1 1 1 0 1 0 0 0	232	C
reset - reason unspecified	1 1 1 0 1 0 0 1	233	Re
reset - congestion	1 1 1 0 1 0 1 0	234	Re
connection rejection - OSI Network			C
address unknown (permanent condition)	1 1 1 0 1 0 1 1	235	C
	. .	.	
	1 1 1 0 1 1 1 1	239	
Higher Layer Initiated	1 1 1 1 0 0 0 0	240	Rr,C,Re
disconnection - normal	1 1 1 1 0 0 0 1	241	C
- abnormal	1 1 1 1 0 0 1 0	242	C
- incompatible information in user data	1 1 1 1 0 0 1 1	243	C
connection rejection - reason unspecified (transient condition)	1 1 1 1 0 1 0 0	244	C
connection rejection - reason unspecified (permanent condition)	1 1 1 1 0 1 0 1	245	C
connection rejection - requested quality of service not available (transient condition)	1 1 1 1 0 1 1 0	246	C
connection rejection - requested quality of service not available (permanent condition)	1 1 1 1 0 1 1 1	247	C
connection rejection - incompatible information in user data	1 1 1 1 1 0 0 0	248	C
connection rejection - unrecognizable protocol identifier in user data	1 1 1 1 1 0 0 1	249	C
reset - resynchronization	1 1 1 1 1 0 1 0	250	Re
	. .	.	
	0 1 1 1 1 1 1 1	255	

With reference to Table H_1:

Notes:

1. - A given diagnostic need not apply to all packet types. The packet type(s) to which each diagnostic may apply are shown where:

   a. D=DIAGNOSTIC; Rr=RESTART_REQUEST/INDICATION; C=CLEAR_REQUEST/INDICATION; Re=RESET_REQUEST/INDICATION; and Rg=REGISTRATION_CONFIRMATION; and

   b. additionally, for diagnostic codes in packets transmitted by a DTE: Re=CLEAR_REQUEST and RESTART_REQUEST; C=RESTART_REQUEST; and

   c. hence, additionally, for packets received by a DTE operating in a DTE/DTE environment: Re=CLEAR_INDICATION and RESTART_INDICATION; C=RESTART_INDICATION.

2. - Codes in DTE-originated packets must correspond to the diagnostics specified here when the associated cause code is x′00′. Codes 224-255 support the OSI Network Service Definition.

3. - The first diagnostic in each grouping is a generic diagnostic and can be used in place of the more specific diagnostics within the grouping. The diagnostic #0 (x′00′) can be used in situations where no additional information is available (e.g., where the more specific diagnostics are not implemented).

4. - In certain situations, multiple diagnostic codes may apply. For example, if a timer has expired and a (RESTART, CLEAR, or RESET) REQUEST packet is to be retransmitted, then the DTE may use the diagnostic code associated with the original error or the corresponding "timer expired" diagnostic code.

5. § - This diagnostic may also apply to a maintenance action within a national network.

H.2 SNA-Specific DTE Generated Diagnostic Codes

Table H_2: SNA_specific DTE_Diagnostics (Notes 1, 2 and 3)	HEX	Bits 8765 4321	Decimal
Normal Initialization or Termination	00	0000 0000	0
Invalid Ps	01	0000 0001	1
Invalid Pr	02	0000 0010	2
	..	. .	..
Invalid LLC Type	0C	0000 1100	12
	..	. .	..
	0F	0000 1111	15
Invalid Packet Type (General)	10	0001 0000	16
for State r1	11	0001 0001	17
for State r2	12	0001 0010	18
for State r3	13	0001 0011	19
for State p1	14	0001 0100	20
for State p2	15	0001 0101	21
for State p3	16	0001 0110	22
for State p4	17	0001 0111	23
for State p5	18	0001 1000	24
for State p6	19	0001 1001	25
for State p7	1A	0001 1010	26
for State d1	1B	0001 1011	27
for State d2	1C	0001 1100	28
for State d3	1D	0001 1101	29
	..	. .	..
	1F	0001 1111	31
DCE Timer Expired (General)	20	0010 0000	32
Incoming Call	21	0010 0001	33
Clear Indication	22	0010 0010	34
Reset Indication	23	0010 0011	35
Restart Indication	24	0010 0100	36
	..	. .	..
Unauthorized INTERRUPT_CONFIRMATION	2B	0010 1011	43
Unauthorized INTERRUPT	2C	0010 1100	44
	..	. .	..
	2F	0010 1111	47
DTE Timer Expired (General)	30	0011 0000	48
Call Request	31	0011 0001	49
Clear Request	32	0011 0010	50
Reset Request	33	0011 0011	51
Restart Request	34	0011 0100	52
	..	. .	..
Reject Not Subscribed to	37	0011 0111	55
	..	. .	..
	3F	0011 1111	63

Table H_2: SNA_Specific DTE Diagnostics – (Cont'd)	HEX	Bits 8 7 6 5 4 3 2 1	Decimal
Unassigned (General)	40	0 1 0 0 0 0 0 0	64
	..	. .	.
Invalid Called Address	43	0 1 0 0 0 0 1 1	67
Invalid Calling Address	44	0 1 0 0 0 1 0 0	68
	..	. .	.
	47	0 1 0 0 0 1 1 1	71
Call Collision	48	0 1 0 0 1 0 0 0	72
Unassigned (General)	49	0 1 0 0 1 0 0 1	73
	..	. .	.
	4F	0 1 0 0 1 1 1 1	79
QLLC Error (General)	50	0 1 0 1 0 0 0 0	80
Undefined C-field	51	0 1 0 1 0 0 0 1	81
Unexpected C-field	52	0 1 0 1 0 0 1 0	82
Missing I-field	53	0 1 0 1 0 0 1 1	83
Undefined I-field	54	0 1 0 1 0 1 0 0	84
I-field Too Long	55	0 1 0 1 0 1 0 1	85
Frame Reject Received	56	0 1 0 1 0 1 1 0	86
Header Invalid	57	0 1 0 1 0 1 1 1	87
Data Received in Wrong State	58	0 1 0 1 1 0 0 0	88
Time-out Condition	59	0 1 0 1 1 0 0 1	89
Nr Invalid	5A	0 1 0 1 1 0 1 0	90
Recovery Rejected or Terminated	5B	0 1 0 1 1 0 1 1	91
XID Negotiation in Wrong State	5C	0 1 0 1 1 1 0 0	92
ELLC Time-out Condition	5D	0 1 0 1 1 1 0 1	93
'Q' Bit Discrepancy	5E	0 1 0 1 1 1 1 0	94
	5F	0 1 0 1 1 1 1 1	95
PSH Error (General)	60	0 1 1 0 0 0 0 0	96
Sequence Error	61	0 1 1 0 0 0 0 1	97
Header too Short	62	0 1 1 0 0 0 1 0	98
PSH Format Invalid	63	0 1 1 0 0 0 1 1	99
Command Undefined	64	0 1 1 0 0 1 0 0	100
Protocol Invalid	65	0 1 1 0 0 1 0 1	101
Data Received in Wrong State	66	0 1 1 0 0 1 1 0	102
	..	. .	...
Time-out Condition	69	0 1 1 0 1 0 0 1	105
	..	. .	...
	6F	0 1 1 0 1 1 1 1	111
PAD Error (General)	70	0 1 1 1 0 0 0 0	112
PAD Access Facility Failure	71	0 1 1 1 0 0 0 1	113
SDLC FCS Error	72	0 1 1 1 0 0 1 0	114
SDLC Time-out	73	0 1 1 1 0 0 1 1	115
SDLC Frame Invalid	74	0 1 1 1 0 1 0 0	116
I-field too long	75	0 1 1 1 0 1 0 1	117
SDLC Sequence Error	76	0 1 1 1 0 1 1 0	118
SDLC Frame Aborted	77	0 1 1 1 0 1 1 1	119
SDLC FRMR Received	78	0 1 1 1 1 0 0 0	120
SDLC Response Invalid	79	0 1 1 1 1 0 0 1	121
	..	. .	...
Invalid Packet Type	7B	0 1 1 1 1 0 1 1	123
	..	. .	...
PAD Inoperable	7F	0 1 1 1 1 1 1 1	127

Table H_2: SNA_Specific DTE Diagnostics - (Cont'd)	HEX	Bits 8765 4321	Decimal
DTE-Specific (General)	80	1 0 0 0 0 0 0 0	128
8100_DPPX-Specific	81	1 0 0 0 0 0 0 1	129
INN_QLLC-Specific	82	1 0 0 0 0 0 1 0	130
. . . .	83	. .	131
. . . .	84	. .	132
. . . .	85	. .	133
. . . .	86	. .	134
. . . .	87	. .	135
. . . .	88	. .	136
. . . .	89	. .	137
. . . .	8A	. .	138
. . . .	8B	. .	139
. . . .	8C	. .	140
. . . .	8D	. .	141
. . . .	8E	. .	142
INN_QLLC-Specific	8F	1 0 0 0 1 1 1 1	143
Network Specific	90	1 0 0 1 0 0 0 0	144
DDX-P RNR Packet Received	91	1 0 0 1 0 0 0 1	145
	..	. .	...
	9F	1 0 0 1 1 1 1 1	159
Packet Not Allowed (General)	A0	1 0 1 0 0 0 0 0	160
Invalid 'M' bit Packet Sequence	A1	1 0 1 0 0 0 0 1	161
Invalid Packet Type Received	A2	1 0 1 0 0 0 1 0	162
Invalid Packet on PVC	A3	1 0 1 0 0 0 1 1	163
Unassigned LC	A4	1 0 1 0 0 1 0 0	164
Diagnostic Packet Received	A5	1 0 1 0 0 1 0 1	165
Packet too short	A6	1 0 1 0 0 1 1 0	166
Packet too long	A7	1 0 1 0 0 1 1 1	167
Invalid GFI	A8	1 0 1 0 1 0 0 0	168
Not Identifiable	A9	1 0 1 0 1 0 0 1	169
Not Supported	AA	1 0 1 0 1 0 1 0	170
Invalid Ps	AB	1 0 1 0 1 0 1 1	171
Invalid Pr	AC	1 0 1 0 1 1 0 0	172
Invalid 'D' bit Received	AD	1 0 1 0 1 1 0 1	173
Invalid 'Q' bit Received	AE	1 0 1 0 1 1 1 0	174
	AF	1 0 1 0 1 1 1 1	175
DTE Specific (NPSI Gate/Date) (General)	B0	1 0 1 1 0 0 0 0	176
No LU-to-LU Session	B1	1 0 1 1 0 0 0 1	177
ABEND 703 In Progress	B2	1 0 1 1 0 0 1 0	178
Cancel CHAIN Command	B3	1 0 1 1 0 0 1 1	179
	..	. .	...
	BF	1 0 1 1 1 1 1 1	191
DTE Specific (General)	C0	1 1 0 0 0 0 0 0	192
Termination Pending	C1	1 1 0 0 0 0 0 1	193
Channel Inoperative	C2	1 1 0 0 0 0 1 0	194
Unauthorized Interrupt Confirmation	C3	1 1 0 0 0 0 1 1	195
Unauthorized Interrupt Request	C4	1 1 0 0 0 1 0 0	196
PU Not Available	C5	1 1 0 0 0 1 0 1	197
Inactivity Time-Out	C6	1 1 0 0 0 1 1 0	198
Incompatible Line Configuration	C7	1 1 0 0 0 1 1 1	199
RESET_INDICATION for PAD, translated from signal	C8	1 1 0 0 1 0 0 0	200
DTE Not Operational	C9	1 1 0 0 1 0 0 1	201
	..	. .	...
	CF	1 1 0 0 1 1 1 1	207

Table H_2: SNA_Specific DTE Diagnostics – (Cont'd)	HEX	Bits 8 7 6 5	Bits 4 3 2 1	Decimal
Resources (General)	D0	1 1 0 1	0 0 0 0	208
Buffers depleted	D1	1 1 0 1	0 0 0 1	209
PIU too long	D2	1 1 0 1	0 0 1 0	210
	..	.	.	...
	DF	1 1 0 1	1 1 1 1	223
Local Procedure Error (General)	E0	1 1 1 0	0 0 0 0	224
Packet with LC=0 not Received	E1	1 1 1 0	0 0 0 1	225
RESTART, DIAGNOSTIC, REGISTRATION on LCI ≠ x'000'	E2	1 1 1 0	0 0 1 0	226
INCOMING_CALL Received on Wrong LC	E3	1 1 1 0	0 0 1 1	227
Facility not Subscribed	E4	1 1 1 0	0 1 0 0	228
Packet Not RESTART or DIAG on LCI = x'000'	E5	1 1 1 0	0 1 0 1	229
Facility Parameters not Supported	E6	1 1 1 0	0 1 1 0	230
Facility not Supported	E7	1 1 1 0	0 1 1 1	231
Unexpected Calling DTE	E8	1 1 1 0	1 0 0 0	232
Invalid 'D' bit Request	E9	1 1 1 0	1 0 0 1	233
RESET INDICATION on Virtual Call	EA	1 1 1 0	1 0 1 0	234
Invalid Protocol Identifier	EB	1 1 1 0	1 0 1 1	235
Connection Identifier Mismatch	EC	1 1 1 0	1 1 0 0	236
Missing Cause/Diagnostic Code	ED	1 1 1 0	1 1 0 1	237
	EE	1 1 1 0	1 1 1 0	238
	EF	1 1 1 0	1 1 1 1	239
Miscellaneous	F0	1 1 1 1	0 0 0 0	240
	..	.	.	...
Link Reset	FA	1 1 1 1	1 0 1 0	250
	..	.	.	...
	FF	1 1 1 1	1 1 1 1	255

With reference to Table H_2:

Notes:

1. All diagnostic codes are not necessarily used by all DTEs, but those that are used have the meaning indicated.
2. The first diagnostic in each grouping is a generic code that may be used in place of the more specific codes within the group.
3. These codes, set by transmitting DTEs, in CLEAR, RESET and RESTART packets that also have the Cause_Code set to x'80' transferred on SNA-to-SNA connections, are normally delivered to the remote DTE in a corresponding INDICATION packet by DCEs. However, DCEs may override DTE requests. In this event, DCEs place a network-generated non-zero Cause Code less than 128 in the Cause field and insert the network Diagnostic Code (see Appendix E) in the Diagnostic Code field of the resulting INDICATION packet delivered to the remote DTE.

Appendix I. Description of DTE Packet Layer Actions

I.1 Introduction

Actions taken by IBM SNA X.25 DTEs as a result of packets received in the various states of the packet layer DTE/DCE interface, as perceived by the DTE, are presented in this appendix as a succession of chained tables, where:

- Figure I-1 on page I-2 is applicable for Any State
- Figure I-2 on page I-3 is applicable for Restarting States - (r1, r2 & r3)
- Figure I-3 on page I-6 is applicable for Call Setup and Clearing States - (p1, p2, p3, p4, p5, p6 & p7)
- Figure I-4 on page I-8 is applicable for Data Transfer States - (d1, d2 & d3)
- Figure I-5 on page I-9 is applicable for Interrupt States - (i1, i2, j1 & j2)
- Figure I-6 on page I-10 is applicable for Flow Control States - (f1, f2, g1 & g2)

Note:

The Interrupt and Flow Control States are independent of one another and exist in parallel. That is, a logical channel is simultaneously in one of the two 'i' states, one of the two 'j' states, one of the two 'f' states and one of the two 'g' states whenever the interface in is the Flow Control Ready State (d1).

I.1.1 Rules and Conventions

The following rules and conventions apply for all the tables in this appendix.

- IBM SNA X.25 DTEs discontinue normal processing of a received packet when an error is encountered and the order of packet decoding and checking is not specified. Thus, a single diagnostic code is associated with any error indicated by the DTE when more than one error is associated with a packet.
- Actions taken by the DTE are specified in the tables as:
  - DISCARD: the DTE discards the received packet and takes no subsequent action as a direct result of having received that packet; the state of the DTE/DCE interface as perceived by the DTE remains unchanged. In SNA environments, a higher layer is also informed using the indicated diagnostic code if a diagnostic code is specified.
  - DIAGNOSTIC CODES: are specified in the tables, where applicable, by the '#' symbol. Appendix H, "DTE-Generated Diagnostic Codes" provides a list of the diagnostic codes which may be used by IBM SNA X.25 DTEs.

- ADVISE #'x': the DTE discards the received packet and reports the occurrence of the condition indicated by '#' to a higher layer of SNA; the state of the DTE/DCE interface, as perceived by the DTE, remains unchanged. If operating in a DTE/DTE environment, the DTE should also send a DIAGNOSTIC packet if implemented.
- NORMAL or ERROR: the corresponding action is specified following each table.
- STATE TRANSITIONS: are specified in the tables, where applicable, by the (li) notation; where 'l' is a lower case letter and 'i' is a numeric variable which together identify the resulting state, if any.

- The tables are arranged in order of priority with Table I-1 having the highest priority and subsequent tables having lower priority. Priority means that when a state belonging to a higher order table is specified, that table becomes the applicable table.

Note:

In some DTE implementations, certain states (e.g., r3, p7, d3 and j2) may be transient (i.e., the Packet Layer entering one of the states as a result of an incoming packet will leave the state by generating the prescribed response before processing any subsequent incoming packet). The reactions to incoming packets given in these Packet Layer State tables do not apply to states that are implemented as transient since such events cannot occur.

I.2 DTE State/Action Tables

TABLE I_1: Actions Taken by the DTE Upon Receipt of Packets in Any State of the Packet Layer DTE/DCE Interface as Perceived by the DTE for SPECIAL SITUATIONS

Packet Received by the DTE	Any State
Length < 2 octets (including correctly received I frames containing no packet information)	ADVISE #166
Packet with Invalid General Format Identifier (GFI) (i.e., ¬= x'1, 2, 5, 6, 9, A, D or E')	ADVISE #168
Packet with Unassigned LCID	ADVISE #164
DIAGNOSTIC Packet Received	ADVISE #165
Any packet with a valid GFI and an assigned LCID (including an LCID = x'000')	See Table I_2

Figure I-1. DTE Actions in Special Situations

With reference to Table I_1:

Note: IBM SNA X.25 DTEs also report the contents of the Diagnostic code and Explanation fields to a higher layer.

Table I_2: Actions Taken by DTEs Upon Receipt of Packets in Restart-Related States of the Packet Layer DTE/DCE Interface as Perceived by the DTE

State / Packet Received by the DTE	Packet Layer Ready (r1)	DTE RESTART REQUEST (r2)	DCE RESTART INDICATION (r3)
Unidentifiable Packet with LCID = x'0000'	ADVISE #169	DISCARD	ERROR (r2) #169
Unidentifiable Packet with LCID not = x'0000'	Table I_3	DISCARD #169	ERROR (r2) #169
Undefined or Not Supported Packet (Note 2) with LCID = x'0000'	ADVISE #229	DISCARD #229	ERROR (r2) #229
Undefined or Not Supported Packet (Note 2) with LCID not = x'0000'	Table I_3	DISCARD #170	ERROR (r2) #170
RESTART_INDICATION, RESTART_CONFIRMATION, or Registration (if supported) with LCID not = '000'	Table I-3	DISCARD	ERROR (r2) #226
RESTART_INDICATION or RESTART_CONFIRMATION with a format error (Note 1)	ADVISE #166, 167 or 237	ERROR #166, 167 or 237	DISCARD #166, 167 or 237
RESTART_INDICATION	NORMAL (r3)	NORMAL (p1 or d1) Note 4	DISCARD #36
DCE_RESTART_CONFIRMATION	ERROR (r2) #17	NORMAL (p1 or d1) Note 4	ERROR (r2) #19
REGISTRATION_REQUEST or REGISTRATION_CONFIRMATION packet with a format error (Note 8)	ADVISE #166, 167 or 237	ERROR #166, 167 or 237	ERROR (r2) #166, 167 or 237
REGISTRATION_REQUEST or REGISTRATION_CONFIRMATION packet (Note 6,7)	NORMAL	NORMAL	NORMAL
Packet, other than a Restart, Registration (if supported), or DIAGNOSTIC, supported by the DTE with LCID = '000' (Notes 2,3)	ADVISE #164	ADVISE #164	ADVISE #164
Call Setup, Call Clearing, DATA, Interrupt, Flow Control, or Reset packet	See Table I-3	DISCARD	ERROR (r2) #19

Figure I-2. DTE Actions in Restart-Related States

With reference to Table I_2:

Notes:

1. Formats for RESTART packets are described in section 5.5.

2. REJECT or Registration packets are not supported when the DTE is not capable of using the Packet_Retransmission Facility or the On-line_Facility_Registration Facility, respectively. If the DTE is capable of using the On-line_Facility_Registration Facility but is capable of acting only as an initiator or only as a responder for the registration procedure, then a REGISTRATION_REQUEST packet or a REGISTRATION_CONFIRMATION packet, respectively, is not supported.

3. If the REGISTRATION_REQUEST packet or REGISTRATION_CONFIRMATION packet is not supported (see note 2 above), then the packet is treated as "any packet with LCID ='000'" and the corresponding action invoked.

4. State (p1) for virtual calls or state (d1) for permanent virtual circuits.

5. Formats for the DIAGNOSTIC packets are described in 5.6.

6. Processing of Registration packets is as indicated except if any of the following conditions has occurred:

   - In cases where the DTE only acts as an initiator for the registration procedure, a received REGISTRATION_REQUEST packet is treated as a packet not supported.

   - In cases where the DTE only acts as a responder for the registration procedure, a received REGISTRATION_CONFIRMATION packet is treated as a packet not supported.

   - In cases where the DTE can act as a responder for the registration procedure, a DTE receiving a REGISTRATION_REQUEST packet when use of the registration procedure has not been agreed to transmit a REGISTRATION_CONFIRMATION packet with the cause "Local Procedure Error", diagnostic "Packet type not compatible with facility", and no Registration Field. Otherwise, the REGISTRATION_REQUEST packet is processed as indicated.

   - In cases where the DTE can act as an initiator for the registration procedure, a DTE receiving a REGISTRATION_CONFIRMATION packet when an unconfirmed REGISTRATION_REQUEST packet is not outstanding (including the case where use of the registration procedure has not been agreed to) discards the packet. Otherwise, the REGISTRATION_CONFIRMATION packet is processed as indicated.

7. A REGISTRATION_REQUEST packet may be received, in a DTE/DTE environment, only if the agreement to use the On-line_Facility_Registration Facility includes the DTE responding to registration-procedure initiation.

When receiving a REGISTRATION_REQUEST packet modifying one or more of the facilities that can take effect only when all logical channels used for Virtual Calls are in state P1 and it is possible to make the modification, the DTE invokes the ERROR procedure (with cause indicating "DTE Originated" and the diagnostic "Registration/Cancellation Confirmed") if there is one or more logical channels assigned to Permanent Virtual Circuits. This action ensures that the Permanent Virtual Circuits are reset so that all of the negotiated facilities can properly take effect.

8. Formats for Registration packets are described in 5.7.2 and 7.0.

NORMAL (ri):

Actions taken by IBM SNA X.25 DTEs, when no error condition has occurred, are as defined in §§ 3.3 and 4.0 and the DTE/DCE interface enters state (ri).

ERROR # (r2):

DTEs discard the received packet, report the error condition to a higher layer and transmit a RESTART_REQUEST packet across the DTE/DCE interface placing all the logical channels in the DTE_RESTART_REQUEST state (r2).

TABLE I_3: Actions Taken by the DTE Upon Receipt of Packets in the Call Setup and Clearing Related States of the Packet Layer DTE/DCE Interface as Perceived by the DTE

	PACKET LAYER READY r1						
State / Packet Received from DCE	READY p1	DTE WAIT p2	DCE WAIT p3	DATA XFER p4	CALL COLL p5	DTE CLEAR RQST p6	DCE CLEAR IND. p7
Unidentifiable Packet	ERROR (p6) #169	ERROR (p6) #169	ERROR (p6) #169	TABLE I_4	ERROR (p6) #169	DISC	ERROR (p6) #169
Undefined or Not Supported	ERROR (p6) #170	ERROR (p6) #170	ERROR (p6) #170	TABLE I_4	ERROR (p6) #170	DISC	ERROR (p6) #170
Restart or Registration (if supported) with LCID ¬= x'000'	ERROR (p6) #226	ERROR (p6) #226	ERROR (p6) #226	TABLE I_4	ERROR (p6) #226	DISC	ERROR (p6) #226
INCOMING_CALL	NORMAL (p3) Notes 1, 2	NORMAL (p5) Notes 1, 3	ERROR (p6) #22	ERROR (p6) #23	ERROR (p6) #24	DISC (p6)	ERROR (p6) #26
CALL_CONNECTED (Note 2)	ERROR (p6) #20	NORMAL (p4) or ERROR (p6) Note 4	ERROR (p6) #22	ERROR (p6) #23	NORMAL (p4) or ERROR (p6) Notes 4,5	DISC (p6)	ERROR (P6) #26
CLEAR_INDICATION (Note 2)	NORMAL (p7)	NORMAL (p7)	NORMAL (p7)	NORMAL (p7)	NORMAL (p7)	NORMAL (p1)	DISC
DCE_CLEAR_CONFIRMATION (Note 2)	ERROR (p6) #20	ERROR (p6) #21	ERROR (p6) #22	ERROR (p6) #23	ERROR (p6) #24	NORMAL (p1)	ERROR (p6) #26
OTHER PACKETS	ERROR (p6) #20	ERROR (p6) #21	ERROR (p6) #22	TABLE I_4	ERROR (p6) #24	DISC	ERROR (p6) #26

Figure I-3. DTE Actions in Call Setup and Clearing States

With reference to Table I_3:

Notes:

1. For one-way outgoing logical channels, DTEs transmit CLEAR_REQUEST with the diagnostic code #227 on SNA-to-SNA connections.

2. If the packet is acceptable to the state of the logical channel (i.e., NORMAL) but contains a format error or is otherwise unacceptable, then the DTE will invoke the ERROR procedure. Formats for Call Setup and Call Clearing packets are described in 5.2; formats for facility information are described in 7. In addition to being properly formatted, address information must contain the correct number of digits and specify a valid address. A facility code that is not supported or that does not apply to a DTE/DTE environment may be ignored or treated as an error. If the DTE chooses to treat

this situation as an error, then it invokes the ERROR procedure (with diagnostic "Facility/registration not allowed").

3. If the INCOMING CALL packet contains a format error or is otherwise unacceptable, then

    - in a DTE/DTE environment, if the DTE is acting as a DCE for the purpose of resolving call collisions (see 4.1.6), it shall act as in Note 2.
    - otherwise, the DTE may invoke the ERROR procedure.

    Formats for call setup packets are described in 5.2. In addition to being properly formatted, address information must contain the correct number of digits and specify a valid address. A facility code that is not supported or that does not apply in a DTE/DTE environment may be ignored or treated as unacceptable; in the later case, diagnostic code "Facility/registration code not allowed" applies if the DTE invokes the error procedure.

4. The use by the calling DTE of the Fast Select Facility with a restriction on the response prohibits the DCE/remote DTE from sending a CALL_CONNECTED packet.

5. In a DTE/DTE environment, the DTE that acts as a DCE for purposes of resolving call collisions (see 4.1.6) will invoke the ERROR procedure (with diagnostic = "Packet type invalid for state P5").

ERROR:

DTES report an error situation, using the indicated diagnostic code, and clear the virtual call or reset the permanent virtual circuit by transmitting a CLEAR/RESET_REQUEST packet across the DTE/DCE interface. Some DTEs may optionally restart the DTE/DCE interface by transmitting a RESTART_REQUEST packet.

DISC:

The packet is discarded. No state transition occurs.

NORMAL (pi):

DTEs process the received packet in accordance with procedures defined in Chapter 4, "Procedures for Virtual Circuit Services."

TABLE I_4: Actions Taken by the DTE Upon Receipt of Packets in Reset-Related States of the Packet Layer DTE/DCE Interface as Perceived by the DTE			
	DATA TRANSFER p4		
State / Packet Received from the DCE	FLOW CONTROL READY (d1)	DTE RESET REQUEST (d2)	DCE RESET INDICATION (d3)
Unidentifiable	ERROR (d2) #169	DISCARD	ERROR (d2) #169
Undefined or Not Supported	ERROR (d2) #170	DISCARD	ERROR (d2) #170
Restart or Registration (if supported) with LCID ¬= x'000'	ERROR (d2) #226	DISCARD	ERROR (d2) #226
RESET_INDICATION (Note 1)	NORMAL (d3)	NORMAL (d1 or p6)	DISCARD (d3) #35
DCE_RESET_CONFIRMATION (Note 1)	ERROR (d2) #27	NORMAL (d1 or p6)	ERROR (d2) #29
REJECT supported but not subscribed to	ERROR (d2) #228	DISCARD	ERROR (d2) #228
[INTERRUPT]	Table I-5	DISCARD	ERROR (d2) #29
DATA or Flow Control	Table I-6	DISCARD	ERROR (d2) #29
INVALID PACKET TYPE, QLLC ERROR, PSH ERROR or PACKET NOT SUPPORTED	ERROR (d2)	DISCARD See Attachment H for Diagnostic Codes	ERROR (d2)

Figure I-4. DTE Actions in Data Transfer States

With reference to Table I_4:

Note:

If the packet is acceptable to the state of the logical channel (i. e., NORMAL) but contains a format error, then the DTE will invoke the ERROR procedure. Formats for Reset packets are described in 5.4.3.

ERROR # (di):

DTEs discard the packet, report the error condition using the # diagnostic code and clear the virtual call or reset the permanent virtual circuit by transmitting a CLEAR/RESET_REQUEST packet across the DTE/DCE interface.

Some DTEs may optionally restart the DTE/DCE interface by transmitting a RESTART_REQUEST packet across the DTE/DCE interface.

NORMAL (di):

Provided none of the following error conditions or special situations has occurred, the actions taken by the DTE follow the procedures defined in § 4:

- If the packet exceeds the maximum permitted length, is too short, is not octet aligned, see rule 2) in the introduction to this appendix, the DTE will invoke the ERROR #39, #38, or #82 procedure, respectively.
- If the Ps or Pr received is not valid, the DTE will invoke the ERROR #1 or #2 procedure, respectively.
- The DTE will consider the receipt of a DCE_INTERRUPT or DCE_INTERRUPT_CONFIRMATION packet on an SNA-to-SNA connection as an error and will invoke the ERROR #170.

Table I_5: Actions taken by DTEs on receipt of packets in Interrupt-Related States of the Packet Layer DTE/DCE Interface as Perceived by the DTE

State / Packet Received from DCE	DTE INTERRUPT READY (i1)	DTE INTERRUPT SENT (i2)	DCE INTERRUPT READY (j1)	DCE INTERRUPT SENT (j2)
INTERRUPT (Note 1)	NORMAL	NORMAL	NORMAL (j2)	ERROR (d2) #44
INTERRUPT_CONFIRMATION (Note 1)	ERROR (d2) #43	NORMAL (i1)	NORMAL	NORMAL

Figure I-5. DTE Actions in Interrupt States

With reference to Table I_5:

Note:

If the packet is acceptable relative to the state of the logical channel (i. e., NORMAL) but contains a format error, then the DTE will invoke the ERROR procedure. Formats for Interrupt packets are described in 5.3.2 and 5.3.3.

ERROR # (i|ji):

the DTE discards the received packet and initiates a resetting procedure by transferring a RESET_REQUEST packet across the DTE/DCE Interface for the logical channel specified in the received packet and starts Timer T22. The Resetting Cause Field of the RESET_REQUEST packet should be coded "DTE Originated" and the Diagnostic Code field should be coded '#'. At this time, the logical channel is in the DTE_Reset_Request state (d2).

NORMAL (i|j1):

If the received packet is acceptable relative to the state of the logical channel (i.e., NORMAL) but contains a format error, then the DTE will invoke the ERROR procedure (diagnostic codes that may apply include #166 or #167).

Table I_6: Actions Taken by the DTE Upon Receipt of Packets in Flow Control-Related States of the Packet Layer DTE/DCE Interface as Perceived by the DTE

State Packet Received from DCE	DCE RECEIVE READY (f1)	DCE RECEIVE NOT READY (f2)	DTE RECEIVE READY (g1)	DTE RECEIVE NOT READY (g2)
RR, RNR, or REJECT (if subscribed to) with < 4 octets when using modulo 128 packet sequence numbering	ERROR (d2) #166 or DISCARD	ERROR (d2) #166 or DISCARD	ERROR (d2) #166 or DISCARD	ERROR (d2) #166 or DISCARD
RR, RNR, or REJECT (if subscribed to) with an invalid Pr	ERROR (d2) #2	ERROR (d2) #2	ERROR (d2) #2	ERROR (d2) #2
RR Packet with a Valid Pr (Note 7)	NORMAL	NORMAL (f1)	NORMAL	NORMAL
RNR Packet with a Valid Pr (Note 7)	NORMAL (f2)	NORMAL	NORMAL	NORMAL
REJECT (if subscribed to) with a Valid Pr (Notes 6, 7)	NORMAL	NORMAL (f1)	NORMAL	NORMAL
DATA with < 4 octets when using modulo 128 Packet Sequence Numbering	ERROR (d2) #166	ERROR (d2) #166	ERROR (d2) #166	ERROR (d2) #166 or DISCARD Note 3
DATA with an Invalid Pr	ERROR (d2) #2	ERROR (d2) #2	ERROR (d2) #2	ERROR (d2) #2
DATA with a valid Pr and an Invalid Ps or User Data Field with Improper Format	ERROR (d2) Note 1	ERROR (d2) Note 1	ERROR (d2) Note 5 or DISCARD Note 5	ERROR (d2) Note 1 or DISCARD Notes 2,3
DATA with a valid Pr and D=1 when the D-bit Procedure is not supported, or M=1 and D=0 with User Data Field partially full, or Q-bit not the same value in all DATA packet of a complete packet sequence	ERROR (d2) Note 2	ERROR (d2) Note 2	ERROR (d2) Note 2	ERROR (d2) Note 2 or DISCARD (Notes 2,3)
DATA with a valid Pr, a valid Ps and a User Data Field with Proper Format	NORMAL	NORMAL	NORMAL	DISCARD Notes 3, 4

Figure I-6. DTE Actions in Flow Control-Related States

With reference to Table I_6:

ERROR # (f|gi):

the DTE discards the received packet and initiates a resetting procedure by transferring a RESET_REQUEST packet across the DTE/DCE Interface for the logical channel specified in the received packet and starts Timer T22. The Resetting Cause Field of the RESET_REQUEST packet should be coded "DTE Originated" and the Diagnostic Code field should be coded '#'. Invoking the ERROR procedure, as described above, clears any receive-not-ready condition that may exist.

NORMAL (f|gi):

If the received packet is acceptable relative to the state of the logical channel (i.e., NORMAL) but contains a format error, then the DTE will invoke the ERROR procedure (diagnostic codes that may apply include #166 or #167).

Notes:

1. The Error procedure may be invoked with the DTE-Originated Cause and the appropriate diagnostic code.
2. Although a RNR condition exists at the DTE, the Pr information contained in the header of a DATA packet should be processed.
3. The DTE may define an internal mechanism to indicate that DATA packets have been discarded during a receive-not-ready condition. In this case, when the receive-not-ready condition clears, one of the recovery mechanisms described in § 4.4 should be invoked.
4. In addition to the state transitions resulting from the receipt of packets, there may be certain internal stimuli that will cause state transitions and the transmission of packets (e.g., local receive-not-ready condition detected/cleared resulting in transmission of a RNR/RR packet).
5. Recovery mechanism (b) or (c) described in 3.4.3 may be invoked to recover from the receipt of an invalid Ps or an invalid User Data Field.
6. Receipt of a second REJECT packet before transfer of the DATA packet with the Ps equal to the Pr indicated in the previous REJECT packet is an error. In this case, the ERROR procedure is invoked (with diagnostic "unauthorized reject").
7. For RR, RNR, or REJECT packets, the presence of one or more octets beyond the third octet when modulo 8 numbering is used (or the fourth octet when modulo 128 numbering is used) is considered an error. Although a valid Pr may be accepted to update the status of outstanding DATA packets, the ERROR procedure should be invoked (with diagnostic "Packet too long"). Alternatively, the packet may be ignored.

Appendix J. Physical Services Headers

Logical Link Control (LLC) using Physical Services Headers (PSH)

IBM SNA X.25 DTEs that communicate with remote IBM 5973 Network Interface Adapters (NIAs) use the Physical Services Header (PSH) to perform the logical link control (LLC) functions described in this appendix.

J.1 Physical Services Header Formats

PSHs have the structure depicted in Figure J-1.

Octet	Bits 8	7	6	5	4	3	2	1
0	SNA Format Identifier (FID FOX) 1	1	1	1	R	SI	PSI	CPI
1	PSC or SN or Data							
2	PSC or PSC Modifier (PSXID and PSTEST Information field as defined for SDLC XID and TEST, respectively) or Data							
3 . n	PSC Modifier or Data							

Legend:

R – Reserved

SI – Segmenting Indicator
- b'1' – More segments to follow
- b'0' – Last or only segment

PSI – Packet Sequence Indicator
- b'1' – Octet 1 = SN
  - – Octet 2 = PSC or Data
- b'0' – Octet 1 = PSC or Data
  - – Octet 2 = PSC Modifier or Data

CPI – Control Present Indicator (Control = PSC or PSC Modifier
- b'1' – Control Present
- b'0' – Control Not Present

PSC – Physical Services Command
- x'02' = PSDISC (DISCONTACT)
- x'04' = PSXID (EXCHANGE ID)
- x'06' = PSTEST (TEST)
- x'08' = PSCONTACT (CONTACT)

SN – Data Packet Sequence Number

Figure J-1. Physical Services Header (PSH): Formats

Note: Octet 2 of the PSCONTACT and PSTEST responses transmitted by a Secondary/Remote IBM 5973 NIA contains the SDLC station address.

PSHs are inserted in front of SNA PIUs transmitted across the network(s), for:

- Adjacent SNA node physical services - traditional SNA functions such as XID, SNRM, and TEST that are mandatory for IBM SNA X.25 DTEs. Adjacent SNA node physical services are performed according to the same criteria as the equivalent normal response mode SDLC functions.
- Data Segmentation - permitting IBM SNA X.25 DTEs to segment user data into packets when the 'M' bit procedure is not used.
- Sequence Numbering - an optional end-to-end packet sequence numbering function to provide for the detection of lost, duplicated or disordered data packets.

IBM SNA X.25 DTEs that must remotely connect to an IBM 5973 Network Interface Adapter (NIA) that support only PSH LLC must implement QLLC with 'M' bit segmenting/segment reassembly as well as PSH LLC.

J.2 Operating Rules

Rules for use of Physical Services Headers on SNA-to-SNA connections, include:

- The first octet of the Call User Data field in call control packets is coded with bits 8 through 1 = x'C2' or x'C6' to identify SNA-to-SNA connections that use PSHs.
- The PSH is used for segmentation. The 'M' bit is not to be set equal to '1' by DTEs in data packets when the PSH is used for segmentation.
- The maximum User Data field length must be the same at both the local and remote DTE/DCE interfaces.
- Although either DTE may use the same PSH commands, the use of these is asymmetric. One DTE, designated 'F', may send PSXID, PSTEST or PSCONTACT at any time. The other DTE, designated 'R', must send PSXID, PSTEST or PSCONTACT only after having received the corresponding command.

  Either DTE may send PSDISC at any time.

  After sending PSXID, PSTEST or PSCONTACT, 'F' waits for a reply from 'R'. There is a timeout associated with this wait.

  If 'F' receives a PSXID, PSTEST or PSCONTACT command which is not in response to a corresponding command 'F' sends PSDISC or may terminate the virtual circuit by clearing, resetting or restarting.

  When either 'F' or 'R' receives a PSDISC it responds by sending a PSDISC command (unless a PSDISC collision has occurred) or else terminates the virtual circuit.
- PSH LLC commands and responses are initiated by the same higher-layer events that initiate their SDLC counterparts (see Figure 20 in § 8).

J.3 Effects of LAPB Link Resetting

Resetting of the data link layer re-initializes LAPB sequence numbering and constitutes an exposure to the integrity of data, for either direction of transmission. Such exposures may be resolved via logical link stations using PSH sequence numbering and verification procedures. When data integrity errors are detected, PSH stations:

- report link outage(s) to a higher layer of SNA; and,
- remove affected virtual circuit(s) from service by clearing virtual calls and resetting permanent virtual circuits.

Appendix K. SNA-to-non_SNA Architectural Considerations

Architectural considerations for SNA-to-non_SNA connections

Three implementations approaches are defined for SNA-to-non_SNA connections. In the first one, virtual circuit functions are mapped to an SNA session at the SNA boundary node permitting support of non_SNA nodes across packet-switched networks with limited effect on the subsystems. The second approach provides a transparent path between the X.25 DTE/DCE interface, residing in some SNA boundary node, and an application program interface which handles all the packets defined in CCITT Recommendation X.25. The third approach can provide various degrees of transparency and mapping for X.25 virtual circuit functions.

K.1 Implementation Approach 1

A Packet-Mode DTE implemented in an SNA PU.T4 or PU.T5 node acts as a boundary function providing conversion between a virtual circuit and an SNA session. The non-SNA remote nodes may establish several virtual circuits across the network to/from the SNA PU.T4/T5. To each of these virtual circuits, there corresponds a session acting as a transportation mechanism towards some application interface in some SNA host node.

The half session in the PU.T4/T5 will have the appearance of either a SLU or a PLU, depending on the direction of call setting. This is to permit future extension to the SNA pass through function.

The following mappings are possible:

- INCOMING_CALL packets may be mapped into either:
  - Request Contact (with a pseudo ID); or,
  - Unformatted INITSELF, carrying the contents of the call user data field and the calling DTE address to the USS of an SSCP that controls the PU.T4/T5.
- +RESP/BIND is mapped into CALL_ACCEPTED.
- CONNOUT and BIND provide information to create CALL_REQUEST.
- CALL_CONNECTED is mapped into +RESP/BIND.
- CLEAR_INDICATION is mapped into UNBIND.
- UNBIND is mapped into CLEAR_REQUEST.
- RESET_INDICATION is mapped into an extended SNA CLEAR.
- SNA CLEAR extended is mapped into RESET_REQUEST.
- INTERRUPT is mapped into SIGNAL, and vice versa.
- The data field of DATA packets are mapped into RUs.

- Complete packet sequences need not necessarily be reassembled in the PU.T4/T5 before transmission within SNA. Chaining can be used within SNA in order to relate unassembled PIUs which belong to the same packet sequence.
- No direct mapping can be established between the X.25 window rotation mechanism for flow control and the SNA pacing mechanism. The PU.T4/T5 will act as an intermediate buffer and will handle flow control on each network as a function of its general memory assignment strategy by use of the appropriate mechanism on each side.
- The 'D' bit is mapped to the form of RESPONSE REQUESTED bits in the RH, where:
  - 'D'='0' corresponding to the exception response indicator set to '1'.
  - 'D'='1' corresponding to the definite response indicator set to '1'.
- Other higher layer SNA functions - such as set and test sequence numbers, brackets and function management header protocols - are not mappable to X.25.

K.2 Implementation Approach 2

A possible architecture to permit transparent handling of X.25 is based on the provision of a single session path between the SNA boundary node and the application as depicted in Figure K-2 on page K-4.

All the virtual circuits are multiplexed on this single session flow. Demultiplexing is performed, by analysis of the logical channel number in the packets, by the application. All of the functions of X.25, being thus handled transparently to SNA, can be supported in this environment.

K.3 Implementation Approach 3

This hybrid approach is a mixture of approaches 1 and 2. Various degrees of X.25 transparent and mapped function can be achieved on given SNA sessions.

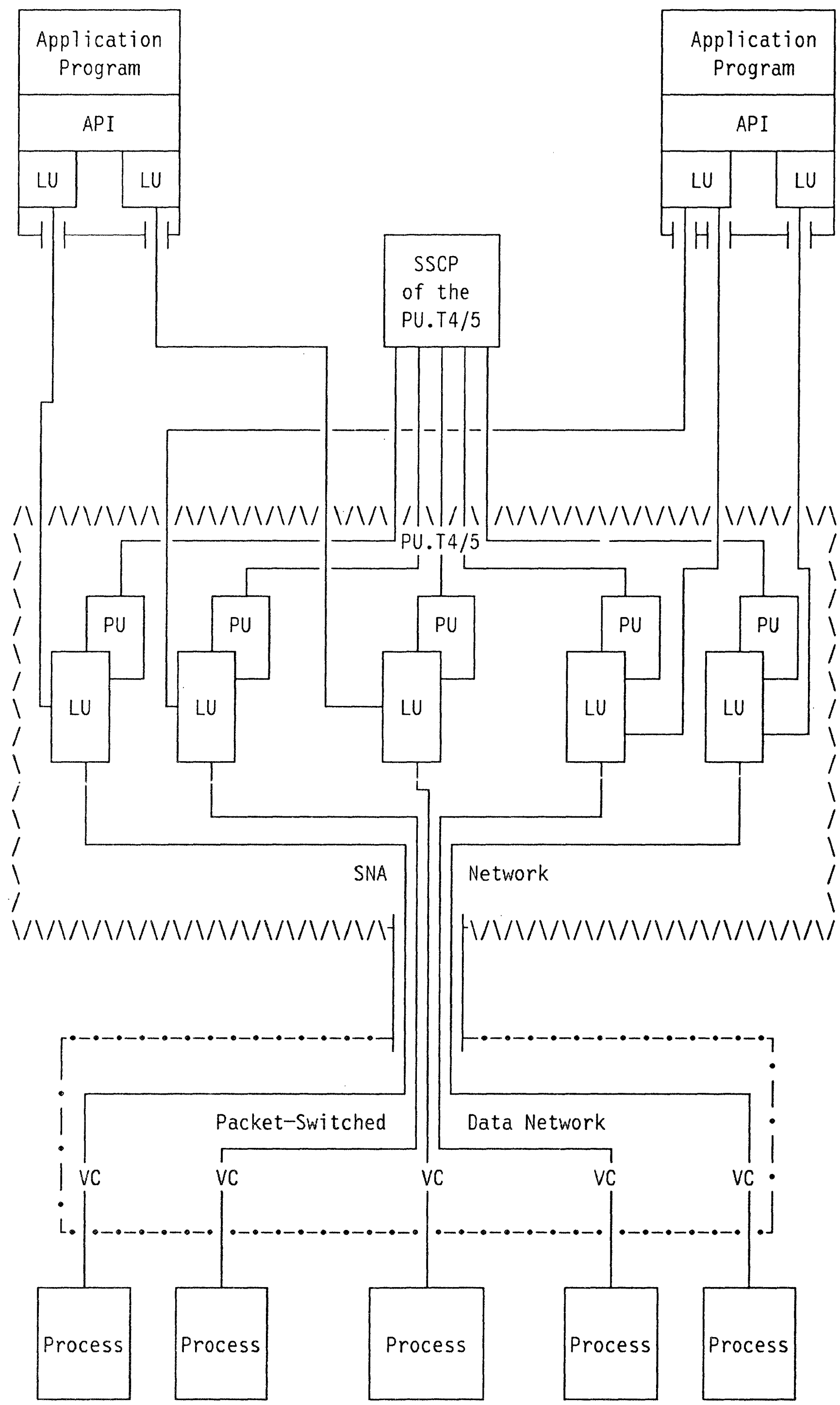


Figure K-1. Virtual Circuit: Relationships to SNA Sessions

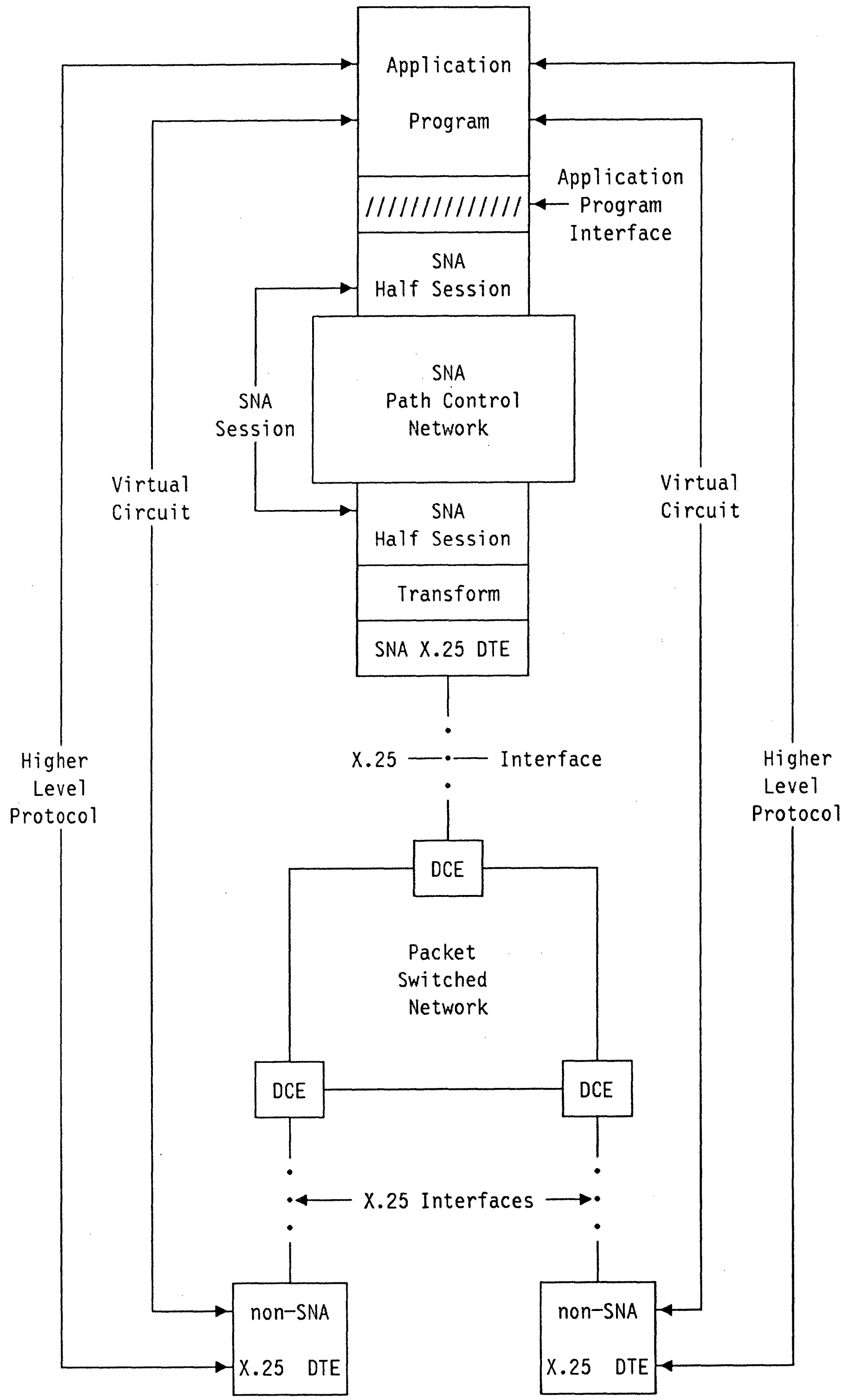


Figure K-2. One Session to Many Virtual Circuits: for SNA-to-non_SNA Connections

Appendix L. LAPB SLP Finite State Machines

The LAPB Single Link Procedure (SLP) described in "Description of the LAPB Procedure" on page 2-20 is formalized by the finite state machines (FSMs) presented in this appendix. These include:

- Table L-1 on page L-6, which specifies the processes, outputs and state transitions resulting from stimuli introduced for link connections perceived to be in one of the seven basic LAPB SLP states;
- Table L-2 on page L-10, which specifies the processes, outputs and state transitions resulting from stimuli introduced for link connections perceived to be in the SLP_FSM OPENED state (Information Transfer Phase); and,
- Table L-3 on page L-16 which specifies the processes, outputs and state transitions resulting from stimuli introduced for link connections perceived to be in the SLP_FSM RECOVER state (Frame Rejection Condition).

L.1 Introduction to Finite State Machines (FSMs)

A finite state machine is a graphical device that provides a formal description of how a mechanism operates. It is especially useful for illustrating the operational definitions of communication architectures. Finite state machines exist in many forms; the following describes how to interpret the finite state machines used in defining the LAPB SLP architecture.

Example: Interpreting SLP_FSM

With reference to Table L-1 on page L-6, assuming state 05, the CLOSING state, and the media_is_inoperative input; the FSM changes to state 01, the INOPERATIVE state, and does the process identified by the output code R01. Looking below the matrix, in the column OUTPUT CODE, we find the letter R01. Now looking to the right of R01, in the Function column, we find a reference to the procedure to be performed. The procedure is Report Status. Refer to the procedure Report Status on the indicated page to see the description of the function to be performed. After the procedure, Report Status, is carried out the reader exits from the FSM: leaving the FSM in state 01, the INOPERATIVE state.

Generic Description: How to Interpret a FSM

To find the actions taken when a specific event takes place, cross-reference that input with the current state. At the intersection is an action code, which consists of a next state indicator and an output code. The next state indicator is either '-', meaning no state change takes place, or a number, which represents the new state. The output code, an alphanumeric identifier, references the output code section located directly after the matrix. Adjacent to the output codes are the functions to be performed.

When a FSM is first activated it is placed in state 01, the initial state; in SLP_FSM the initial state is the INOPERATIVE state; in SLP_FSM_OPENED the initial state is INFO XFER; in SLP_FSM_CHECK_POINT the initial state is the CHECKPOINT RECOVER state.

L.2 LAPB Single Link Procedure

Inputs to the SLP FSMs are common and are listed below for easy reference and to avoid duplication of information.

L.2.1 Events

media_is_operational - The Media_Is_Operational event occurs upon a transition of the Physical Level to the operational state (see §-1.0).

start_the_link - The Start_The_Link event represents a higher layer (user) request to initialize or restart the SLP (Link Set-up, see §-2.4.4.1).

stop_the_link - The Stop_The_Link event represents a higher layer (user) request to terminate SLP operation (Link Disconnection, see §-2.4.4.3).

media_is_inoperative - The Media_Is_Inoperative event represents a transition of the Physical Level to the inoperative state (see §-1.0).

out_of_resources - The Out_Of_Resources event occurs upon detection of a station busy condition, as described in §-2.4.5.8, at the local station.

resources_available - The Resources_Available event occurs when a station busy condition, as described in §-2.4.5.8, is recovered at the local station.

reply_timer_Tp_expired - The Reply_Timer_Tp_Expired event occurs upon expiration of Reply Timer, Tp (see §-2.4.8.1)

query_timer_Tn_expired - The Query_Timer_Tn_Expired event occurs following a period of link inactivity lasting for the duration of Query Timer, Tn (see §§-2.3.4.3, 2.4.5.7 and 2.4.8.8).

illegal_frame - The Illegal_Frame event occurs upon detection of a Frame Rejection Condition as described §§-2.3.4.9 and 2.3.5.4.

invalid_frame - The Invalid_Frame event occurs upon receipt of an invalid frames as described in §-2.3.5.3 flags (see §§-2.2.9 and 2.4.2).

receive_link_channel_is_idle - The Receive_Link_Channel_Is_Idle event occurs upon expiration of the Idle Time-out period, Ti, as described in §-2.2.12.2 (see §-2.4.8.7).

transmit_link_channel_is_ready - The Transmit_Link_Channel_Is_Ready event occurs following transmission of the last bit of the current frame.

send_data - Represents data received from a higher layer that is to be transmitted to the DCE in the information field of an I frame.

L.2.2 Commands

I_frame_CMD_P_0_inseq - Represents the next in-sequence information (I) command frame with the poll (P) bit set to zero, if available, (see §-2.4.5.2) otherwise continuous flag sequences.

I_frame_CMD_P_0_ack_inseq - Represents the next in-sequence information (I) command frame with the poll (P) bit set to zero, and an acknowledgement (an Nr greater than the last Nr received) for previously transmitted I-frame(s), if available, (see §-2.4.5.2) otherwise continuous flag sequences.

I_frame_CMD_P_1_inseq - Represents the next in-sequence information (I) command frame with the poll (P) bit set to one, if available, (see §-2.4.5.2) otherwise continuous flag sequences.

I_frame_CMD_P_1_ack_inseq - Represents the next in-sequence information (I) command frame with the poll (P) bit set to one, and an acknowledgement (an Nr greater than the last Nr received) for previously transmitted I-frame(s), if available, (see §-2.4.5.2) otherwise continuous flag sequences.

I_frame_CMD_P_0_out_of_seq - Represents an out-of-sequence information command frame with the poll (P) bit set to zero (see §§-2.3.5.2 and 2.4.5.2).

I_frame_CMD_P_0_ack_out_of_seq - Represents an out-of-sequence information command frame with the poll (P) bit set to zero, and an acknowledgement (an Nr greater than the last Nr received) for previously transmitted I-frame(s), (see §§-2.3.5.2 and 2.4.5.2).

I_frame_CMD_P_1_out_of_seq - Represents an out-of-sequence information command frame with the poll (P) bit set to one (see §§-2.3.5.2 and 2.4.5.2).

I_frame_CMD_P_1_ack_out_of_seq - Represents an out-of-sequence information command frame with the poll (P) bit set to one, and an acknowledgement (an Nr greater than the last Nr received) for previously transmitted I-frame(s), (see §§-2.3.5.2 and 2.4.5.2).

receive_rdy_frame_CMD_P_0 - Represents a Receive Ready (RR) command frame with the poll (P) bit set to zero (see §-2.3.4.2).

receive_rdy_frame_CMD_P_0_ack - Represents a Receive Ready (RR) command frame with the poll (P) bit set to zero, and an acknowledgement (an Nr greater than the last Nr received) for previously transmitted I-frame(s), (see §-2.3.4.2).

receive_rdy_frame_CMD_P_1 - Represents a Receive Ready (RR) command frame with the poll (P) bit set to one (see §-2.3.4.2).

receive_rdy_frame_CMD_P_1_ack - Represents a Receive Ready (RR) command frame with the poll (P) bit set to one, and an acknowledgement (an Nr greater than the last Nr received) for previously transmitted I-frame(s), (see §-2.3.4.2).

reject_frame_CMD_P_0 - Represents a REJECT (REJ) command frame with the poll (P) bit set to zero (see §-2.3.4.4).

reject_frame_CMD_P_0_ack - Represents a REJECT (REJ) command frame with the poll (P) bit set to zero, and an acknowledgement (an Nr greater than the last Nr received) for previously transmitted I-frame(s) (see §-2.3.4.4).

reject_frame_CMD_P_1 - Represents a REJECT (REJ) command frame with the poll (P) bit set to one (see §-2.3.4.4).

reject_frame_CMD_P_1_ack - Represents a REJECT (REJ) command frame with the poll (P) bit set to one, and an acknowledgement (an Nr greater than the last Nr received) for previously transmitted I-frame(s) (see §-2.3.4.4).

receive_not_rdy_CMD_P_0 - Represents a RECEIVE NOT READY (RNR) command frame with the poll (P) bit set to zero (see §-2.3.4.3).

receive_not_rdy_CMD_P_0_ack - Represents a RECEIVE NOT READY (RNR) command frame with the poll (P) bit set to zero, and an acknowledgement (an Nr greater than the last Nr received) for previously transmitted I-frame(s) (see §-2.3.4.3).

receive_not_rdy_CMD_P_1 - Represents a RECEIVE NOT READY (RNR) command frame with the poll (P) bit set to one (see §-2.3.4.3).

receive_not_rdy_CMD_P_1_ack - Represents a RECEIVE NOT READY (RNR) command frame with the poll (P) bit set to one, and an acknowledgement (an Nr greater than the last Nr received) for previously transmitted I-frame(s) (see §-2.3.4.3).

SABM_frame_CMD_P_0 - Represents a SET ASYNCHRONOUS BALANCED MODE (SABM) command frame with the poll (P) bit set to zero (see §-2.3.4.5).

SABM_frame_CMD_P_1 - Represents a SET ASYNCHRONOUS BALANCED MODE (SABM) command frame with the poll (P) bit set to one (see §-2.3.4.5).

disconnect_frame_CMD_P_0 - Represents a DISCONNECT (DISC) command frame with the poll (P) bit set to zero (see §-2.3.4.6).

disconnect_frame_CMD_P_1 - Represents a DISCONNECT (DISC) command frame with the poll (P) bit set to one (see §-2.3.4.6).

L.2.3 Responses

receive_rdy_frame_RSP_F_0 - Represents a RECEIVE READY (RR) response frame with the final (F) bit set to zero (see §-2.3.4.2).

receive_rdy_frame_RSP_F_0_ack - Represents a RECEIVE READY (RR) response frame with the final (F) bit set to zero, and an acknowledgement (an Nr greater than the last Nr received) for previously transmitted I-frame(s) (see §-2.3.4.2).

receive_rdy_frame_RSP_F_1 - Represents a RECEIVE READY (RR) response frame with the final (F) bit set to one (see §-2.3.4.2).

receive_rdy_frame_RSP_F_1_ack - Represents a RECEIVE READY (RR) response frame with the final (F) bit set to one, and an acknowledgement (an Nr greater than the last Nr received) for previously transmitted I-frame(s), (see §-2.3.4.2).

reject_frame_RSP_F_0 - Represents a REJECT (REJ) response frame with the final (F) bit set to zero (see §-2.3.4.4).

reject_frame_RSP_F_0_ack - Represents a REJECT (REJ) response frame with the final (F) bit set to zero, and an acknowledgement (an Nr greater than the last Nr received) for previously transmitted I-frame(s), (see §-2.3.4.4).

reject_frame_RSP_F_1 - Represents a REJECT (REJ) response frame with the final (F) bit set to one (see §-2.3.4.3).

reject_frame_RSP_F_1_ack - Represents a REJECT (REJ) response frame with the final (F) bit set to one, and an acknowledgement (an Nr greater than the last Nr received) for previously transmitted I-frame(s), (see §-2.3.4.4).

receive_not_rdy_RSP_F_0 - Represents a RECEIVE NOT READY (RNR) response frame with the final (F) bit set to zero (see §-2.3.4.3).

receive_not_rdy_RSP_F_0_ack - Represents a RECEIVE NOT READY (RNR) response frame with the final (F) bit set to zero, and an acknowledgement (an Nr greater than the last Nr received) for previously transmitted I-frame(s), (see §-2.3.4.3).

receive_not_rdy_RSP_F_1 - Represents a RECEIVE NOT READY (RNR) response frame with the final (F) bit set to one (see §-2.3.4.3).

receive_not_rdy_RSP_F_1_ack - Represents a RECEIVE NOT READY (RNR) response frame with the final (F) bit set to one, and an acknowledgement (an Nr greater than the last Nr received) for previously transmitted I-frame(s), (see §-2.3.4.3).

unumbered_ack_frame_RSP_F_0 - Represents an UNNUMBERED ACKNOWLEDGEMENT (UA) response frame with the final (F) bit set to zero (see §-2.3.4.7).

unumbered_ack_frame_RSP_F_1 - Represents an UNNUMBERED ACKNOWLEDGEMENT (UA) response frame with the final (F) bit set to one (see §-2.3.4.7).

disconnect_mode_frame_RSP_F_0 - Represents a DISCONNECTED MODE (DM) response frame with the final (F) bit set to zero (see §-2.3.4.8).

disconnect_mode_frame_RSP_F_1 - Represents a DISCONNECTED MODE (DM) response frame with the final (F) bit set to one (see §-2.3.4.8).

FRMR_frame_RSP - Represents a FRAME REJECT (FRMR) response frame with the final (F) bit set to either zero or one (see §-2.3.4.9).

SLP_FSM

Table L-1.

Function: SLP Finite State Machine

The states of SLP_FSM are as follows :

1. INOPERATIVE - state (01) is assumed by link stations when the physical layer is not operational (See § 1.0).
2. CLOSED - state (02) represents the Disconnected Phase described in § 2.4.4.4.
3. OPENING - state (03) represents the Link Setup Procedure described in § 2.4.4.1.
4. OPENED - state (04) represents the Information Transfer Phase described in § 2.4.4.2.
5. CLOSING - state (05) represents the Disconnection Phase described in § 2.4.4.3.
6. CHECK_POINT - state (06) is assumed by link stations following transmission of an appropriate supervisory command frame with 'P = 1' prompted by expiration of Reply Timer, Tp, (See §§ 2.3.5.2(2) and 2.4.5.9).
7. RECOVERY - state (07) represents the Frame Rejection Condition described in §§ 2.3.4.9, 2.3.5.4 and 2.4.6).

Input: Inputs that are common to this and the other two FSMs are described in "LAPB Single Link Procedure" on page L-1.

When a finite state machine function must change the state of SLP_FSM the following inputs are used.

- go_to_INOPERATIVE_state
- go_to_CLOSED_state
- go_to_OPENING_state
- go_to_OPENED_state
- go_to_CLOSING_state
- go_to_CHECK_POINT_state
- go_to_RECOVERY_state

Inputs	States						
	inoper-ative	closed	opening	opened	closing	check point	recovery
	1	2	3	4	5	6	7
media_is_operational	2(N01)	-(E01)	-(E01)	-(FSMO)	-(E01)	-(FSMC)	-(E01)
start_the_link	-(E01)	3(L04)	-(R01)	-(FSMO)	-(R01)	-(FSMC)	3(R02)
stop_the_link	-(E01)	-(E01)	-(R01)	-(FSMO)	-(R01)	-(FSMC)	5(L03)
media_is_inoperative	-(E01)	1(R01)	1(R01)	-(FSMO)	1(R01)	-(FSMC)	1(R01)
out_of_resources	-(R01)	-(R01)	-(R01)	-(FSMO)	-(R01)	-(FSMC)	-(R01)
resources_available	-(R01)	-(R01)	-(R01)	-(FSMO)	-(R01)	-(FSMC)	-(R01)
reply_timer_Tp_expired	-(E01)	-(E01)	-(I01)	-(FSMO)	-(I02)	-(FSMC)	-(P01)
query_timer_Tn_expired	-(E01)	-(E01)	-(E01)	-(FSMO)	-(E01)	-(FSMC)	-(E01)
+ illegal_frame	-(E01)	-(F02)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(F03)
invalid_frame	-(E01)	-(F01)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(F01)
receive_link_channel_is_idle	-(E01)	-(R01)	-(R01)	-(FSMO)	-(R01)	-(FSMC)	-(R01)
transmit_link_channel_is_ready	-(E01)	-(E01)	-(T01)	-(FSMO)	-(T01)	-(FSMC)	-(T01)
send_data	-(E01)	-(E01)	-(E01)	-(FSMO)	-(E01)	-(FSMC)	-(E01)
I_frame_CMD_P_0_inseq	-(E01)	-(F01)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(D01)
I_frame_CMD_P_0_ack_inseq	-(E01)	-(F01)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(D01)
I_frame_CMD_P_1_inseq	-(E01)	-(D03)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(D01)
I_frame_CMD_P_1_ack_inseq	-(E01)	-(D03)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(D01)
I_frame_CMD_P_0_out_of_seq	-(E01)	-(F01)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(D01)
I_frame_CMD_P_0_ack_out_of_seq	-(E01)	-(F01)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(D01)
I_frame_CMD_P_1_out_of_seq	-(E01)	-(D03)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(D01)
I_frame_CMD_P_1_ack_out_of_seq	-(E01)	-(D03)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(D01)
receive_rdy_frame_CMD_P_0	-(E01)	-(F01)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(D01)
receive_rdy_frame_CMD_P_0_ack	-(E01)	-(F01)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(D01)
receive_rdy_frame_CMD_P_1	-(E01)	-(D03)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(D01)
receive_rdy_frame_CMD_P_1_ack	-(E01)	-(D03)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(D01)
reject_frame_CMD_P_0	-(E01)	-(F01)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(D01)
reject_frame_CMD_P_0_ack	-(E01)	-(F01)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(D01)
reject_frame_CMD_P_1	-(E01)	-(D03)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(D01)
reject_frame_CMD_P_1_ack	-(E01)	-(D03)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(D01)
receive_not_rdy_CMD_P_0	-(E01)	-(F01)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(D01)
receive_not_rdy_CMD_P_0_ack	-(E01)	-(F01)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(D01)
receive_not_rdy_CMD_P_1	-(E01)	-(D03)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(D01)
receive_not_rdy_CMD_P_1_ack	-(E01)	-(D03)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(D01)
+ SABM_frame_CMD_P_0	-(E01)	-(R16A)	-(R08)	-(FSMO)	2(N05)	-(FSMC)	4(R18A)
+ SABM_frame_CMD_P_1	-(E01)	-(R16A)	-(R08)	-(FSMO)	2(N05)	-(FSMC)	4(R18A)
disconnect_frame_CMD_P_0	-(E01)	-(N05)	2(R07)	-(FSMO)	-(R08)	-(FSMC)	2(R08)
disconnect_frame_CMD_P_1	-(E01)	-(N05)	2(R07)	-(FSMO)	-(R08)	-(FSMC)	2(R08)
receive_rdy_frame_RSP_F_0	-(E01)	-(F01)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(F01)
receive_rdy_frame_RSP_F_0_ack	-(E01)	-(F01)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(F01)
receive_rdy_frame_RSP_F_1	-(E01)	-(F01)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(F01)
receive_rdy_frame_RSP_F_1_ack	-(E01)	-(F01)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(F01)
reject_frame_RSP_F_0	-(E01)	-(F01)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(F01)
reject_frame_RSP_F_0_ack	-(E01)	-(F01)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(F01)
reject_frame_RSP_F_1	-(E01)	-(F01)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(F01)
reject_frame_RSP_F_1_ack	-(E01)	-(F01)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(F01)
receive_not_rdy_RSP_F_0	-(E01)	-(F01)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(F01)
receive_not_rdy_RSP_F_0_ack	-(E01)	-(F01)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(F01)
receive_not_rdy_RSP_F_1	-(E01)	-(F01)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(F01)
receive_not_rdy_RSP_F_1_ack	-(E01)	-(F01)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(F01)
unumbered_ack_frame_RSP_F_0	-(E01)	-(F01)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	-(F01)
unumbered_ack_frame_RSP_F_1	-(E01)	-(F01)	4(R01)	-(FSMO)	2(R01)	-(FSMC)	-(F01)
+ disconnect_mode_frame_RSP_F_0	-(E01)	-(F01)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	3(R19)
+ disconnect_mode_frame_RSP_F_1	-(E01)	-(F01)	2(R01)	-(FSMO)	2(R01)	-(FSMC)	-(F01)
+ FRMR_frame_RSP	-(E01)	-(F01)	-(F01)	-(FSMO)	-(F01)	-(FSMC)	3(R19)
go_to_INOPERATIVE_state	-	1	1	1	1	1	1
go_to_CLOSED_state	2	-	2	2	2	2	2
go_to_OPENING_state	3	3	-	3	3	3	3
go_to_OPENED_state	4	4	4	-	4	4	4
go_to_CLOSING_state	5	5	5	5	-	5	5
go_to_CHECK_POINT_state	6	6	6	6	6	-	6
go_to_RECOVERY_state	7	7	7	7	7	7	-

Output Code	Function
D01	Discard the information field contained in the received frame (see §§ 2.4.4.4). Send Frame Reject Response Frame With F equal value of P bit in the received command.
D03	Discard the information field contained in the received frame (see §§ 2.4.4.4). Send Disconnected Mode Response Frame With F equal value of P bit in the received command
E01	A logically erroneous local conditions that may be reported to a higher layer.
FSMO	See "SLP_FSM_OPENED" in Table L-2 on page L-9.
FSMC	See "SLP_FSM_CHECK_POINT" in Table L-3 on page L-15.
F01	Ignore the received frame (see §§ 2.2.9, 2.3.5.3, 2.4).
F02	If the received frame is a command with P = 1, Send Disconnected Mode frame with F = 1 Otherwise Ignore the received frame
F03	If the received frame is a command, Send Frame Reject Response Frame With F equal value of P bit in the received command Otherwise Ignore the received frame
I01	If transmission limit is exceeded then (see § 2.4.8.1) Inform higher layer Go to CLOSED state Else Increment transmission count (see § 2.4.8.4). Send Set Asynchronous Balanced Mode Command Frame With P=1.
I02	If transmission limit is exceeded then (see § 2.4.8.1) Inform higher layer Go to CLOSED state Else Increment transmission count (see § 2.4.8.4). Send Disconnect Command Frame With P=1
L03	Initiate the link disconnection procedure (see § 2.4.4.3). Send Disconnect Command Frame With P=1
L04	Set-up (initialize) the link in accordance with described procedures (see § 2.4.4.1). Send Set Asynchronous Balanced Mode Command Frame With P=1.
N01	Send continous flag sequence to indicate output link channel is active.
N05	Send Disconnected Mode Response Frame With F equal value of P bit in the received command
P01	If transmission limit is exceeded then Send Set Asynchronous Balanced Mode Command Frame With P=1. Go to OPENING state Else Send Frame Reject Response Frame With F equal value of P bit in the received command.
R01	Report Status (as described on page L-21).
R02	Send Set Asynchronous Balanced Mode Command Frame With P=1.
R07	Report Status (as described on page L-21). Send Disconnected Mode Response Frame With F equal the value of the P bit in the received command.
R08	Report Status (as described on page L-21). Send Unnumbered Acknowledgement Response Frame With F equal the value of the P bit in the received command.

Output Code	Function
R16A	Report Status (as described on page L-21). If Enabled and Prepared (as described on page L-22). Then Set send and receive state variables to 0. Send Unnumbered Acknowledgement Response Frame With F equal the value of the P bit in the received command. Go to OPENED state. See Table L-1 on page L-5. Else Send Disconnected Mode Response Frame With F equal the value of the P bit in the received command.
+ R18A	Report Status (as described on page L-21). Send Unnumbered Acknowledgement Response Frame With F equal the value of the P bit in the received command. Set send and receive state variables to 0.
+ R19	Report Status (as described on page L-21). Send Set Asynchronous Balanced Mode Command Frame With P=1.
T01	Start reply timer, Tp, if it is not already running (see § 2.4.8).

SLP_FSM_opened

Table L-2.	
Function:	SLP_FSM_opened Finite State Machine The states of SLP_FSM_OPENED are as follows: 1. INFO XFER - state (01) represents the Information Transfer Phase described in § 2.4.4.2. 2. REJECT - state (02) represents the Rejection Condition described in §§ 2.3.5.2 and 2.4.5.6. 3. LOCAL_BUSY - state (03) represents a Busy Condition, as described in §§ 2.3.5.1 and 2.4.5.8, at the local station. 4. REMOTE_BUSY - state (04) represents a Busy Condition, as described in §§ 2.3.5.1 and 2.4.5.8, at the remote station. 5. BOTH_BUSY - state (05) represents a Busy Condition, as described in §§ 2.3.5.1 and 2.4.5.8, at both the local and remote stations. 6. REJECT_AND_LBUSY - state (06) is a composite of the REJECT state (2) and the LOCAL_BUSY state (3) (see §§ 2.3.5.1, 2.3.5.2, 2.4.5.6, 2.4.5.8). 7. REJECT_AND_RBUSY - state (07) is a composite of the REJECT state (2) and the REMOTE_BUSY state (4) (see §§ 2.3.5.1, 2.3.5.2, 2.4.5.6, 2.4.5.8). 8. REJECT_AND_BBUSY - state (08) is a composite of the REJECT state (2) and the BOTH_BUSY state (5) (see §§ 2.3.5.1, 2.3.5.2, 2.4.5.6, 2.4.5.8).
Input:	Inputs that are common to this and the other two SLP FSMs are described in "LAPB Single Link Procedure" on page L-2. When a finite state machine must change the state of SLP_FSM_OPENED the following inputs are used. • go_to_INFO_XFER_state • go_to_REJECT_state • go_to_LOCAL_BUSY_state • go_to_REMOTE_BUSY_state • go_to_BOTH_BUSY_state • go_to_REJECT_AND_LBUSY_state • go_to_REJECT_AND_RBUSY_state • go_to_REJECT_AND_BBUSY_state

Inputs	States							
	info xfer	reject	local busy	remote busy	both busy	reject and lbusy	reject and rbusy	reject and bbusy
	1	2	3	4	5	6	7	8
media_is_operational	-(E01)	-(E01)	-(E01)	-(E01)	-(E01)	-(E01)	-(E01)	-(E01)
start_the_link	-(E01)	-(E01)	-(E01)	-(E01)	-(E01)	-(E01)	-(E01)	-(E01)
stop_the_link	-(L03A)	1(L03A)	1(L03A)	1(L03A)	1(L03A)	1(L03A)	1(L03A)	1(L03A)
media_is_inoperative	-(R01A)	1(R01A)	1(R01A)	1(R01A)	1(R01A)	1(R01A)	1(R01A)	1(R01A)
out_of_resources	3(R13)	6(R13)	-(E01)	5(R13)	-(E01)	-(E01)	8(R13)	-(E01)
resources_available	-(E01)	-(E01)	-(R14A)	-(E01)	4(R14)	2(R03)	-(E01)	7(R03)
+ reply_timer_Tp_expired	-(I03D)	1(I03A)	1(I04D)	1(I03B)	1(I04A)	1(I04B)	1(I03C)	1(I04C)
query_timer_Tn_expired	-(E01)	-(E01)	-(E01)	1(L01C)	1(L02B)	-(E01)	1(L01)	1(L02)
illegal_frame	-(R05)	1(R05)	1(R05)	1(R05)	1(R05)	1(R05)	1(R05)	1(R05)
invalid_frame	-(F01)	-(F01)	-(F01)	-(F01)	-(F01)	-(F01)	-(F01)	-(F01)
receive_link_channel_is_idle	-(R06)	-(R06)	-(R06)	-(R06)	-(R06)	-(R06)	-(R06)	-(R06)
transmit_link_channel_is_ready	-(N09)	-(N09)	-(N09)	-(N09)	-(N09)	-(N09)	-(N09)	-(N09)
send_data	-(A39)	-(A39)	-(A39)	-(A39)	-(A39)	-(A39)	-(A39)	-(A39)
I_frame_CMD_P_0_inseq	-(K04)	1(K04)	-(D02)	-(K02)	-(D02)	3(D02)	4(K02)	5(D02)
I_frame_CMD_P_0_ack_inseq	-(A31)	1(A31)	-(A05)	-(A02)	-(A05)	3(A05)	4(A02)	5(A05)
I_frame_CMD_P_1_inseq	-(K02)	1(K02)	-(D02)	-(K02)	-(D02)	3(D02)	4(K02)	5(D02)
I_frame_CMD_P_1_ack_inseq	-(A02)	1(A02)	-(A05)	-(A02)	-(A05)	3(A05)	4(A02)	5(A05)
I_frame_CMD_P_0_out_of_seq	2(D07)	-(D11)	-(D02)	7(D07)	-(D02)	-(D02)	-(D05)	-(D02)
I_frame_CMD_P_0_ack_out_of_seq	2(A08)	-(A37)	-(A05)	7(A08)	-(A05)	-(A05)	-(A10)	-(A05)
I_frame_CMD_P_1_out_of_seq	2(D07)	-(D05)	-(D02)	7(D07)	-(D02)	-(D02)	-(D05)	-(D02)
I_frame_CMD_P_1_ack_out_of_seq	2(A08)	-(A10)	-(A05)	7(A08)	-(A05)	-(A05)	-(A10)	-(A05)
receive_rdy_frame_CMD_P_0	-(X13)	-(X13)	-(X13)	1(N09)	3(N09)	-(X13)	2(N09)	6(N09)
receive_rdy_frame_CMD_P_0_ack	-(A32)	-(A32)	-(A32)	1(A32)	3(A32)	-(A32)	2(A32)	6(A32)
receive_rdy_frame_CMD_P_1	-(N06)	-(N06)	-(N07)	1(N06)	3(N07)	-(N07)	2(N06)	6(N07)
receive_rdy_frame_CMD_P_1_ack	-(A17)	-(A17)	-(A19)	1(A17)	3(A19)	-(A19)	2(A17)	6(A19)
reject_frame_CMD_P_0	-(S03)	-(S03)	-(S03)	1(S03)	3(S03)	-(S03)	2(S03)	6(S03)
reject_frame_CMD_P_0_ack	-(A27)	-(A27)	-(A27)	1(A27)	3(A27)	-(A27)	2(A27)	6(A27)
reject_frame_CMD_P_1	-(S05)	-(S05)	-(S06)	1(S05)	3(S06)	-(S06)	2(S05)	6(S06)
reject_frame_CMD_P_1_ack	-(A29)	-(A29)	-(A30)	1(A29)	3(A30)	-(A30)	2(A29)	6(A30)
receive_not_rdy_CMD_P_0	4(N02)	7(N02)	5(N02)	-(N02)	-(N02)	8(N02)	-(N02)	-(N02)
receive_not_rdy_CMD_P_0_ack	4(A15)	7(A15)	5(A15)	-(A15)	-(A15)	8(A15)	-(A15)	-(A15)
receive_not_rdy_CMD_P_1	4(N06A)	7(N06A)	5(N07A)	-(N06A)	-(N07A)	8(N07A)	-(N06A)	-(N07A)
receive_not_rdy_CMD_P_1_ack	4(A17A)	7(A17A)	5(A19A)	-(A17A)	-(A19A)	8(A19A)	-(A17A)	-(A19A)
SABM_frame_CMD_P_0	-(R18A)	1(R18A)	1(R18A)	1(R18A)	1(R18A)	1(R18A)	1(R18A)	1(R18A)
SABM_frame_CMD_P_1	-(R18A)	1(R18A)	1(R18A)	1(R18A)	1(R18A)	1(R18A)	1(R18A)	1(R18A)
disconnect_frame_CMD_P_0	-(R08A)	1(R08A)	1(R08A)	1(R08A)	1(R08A)	1(R08A)	1(R08A)	1(R08A)
disconnect_frame_CMD_P_1	-(R08A)	1(R08A)	1(R08A)	1(R08A)	1(R08A)	1(R08A)	1(R08A)	1(R08A)
receive_rdy_frame_RSP_F_0	-(X13)	-(X13)	-(X13)	1(N09)	3(N09)	-(X13)	2(N09)	6(X09)
receive_rdy_frame_RSP_F_0_ack	-(A32)	-(A32)	-(A32)	1(A32)	3(A32)	-(A32)	2(A32)	6(A32)
+ receive_rdy_frame_RSP_F_1	-(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)
+ receive_rdy_frame_RSP_F_1_ack	-(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)
reject_frame_RSP_F_0	-(S03)	-(S03)	-(S03)	1(S03)	3(S03)	-(S03)	2(S03)	6(S03)
reject_frame_RSP_F_0_ack	-(A27)	-(A27)	-(A27)	1(A27)	3(A27)	-(A27)	2(A27)	6(A27)
+ reject_frame_RSP_F_1	-(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)
+ reject_frame_RSP_F_1_ack	-(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)
receive_not_rdy_RSP_F_0	4(N02)	7(N02)	5(N02)	-(N02)	-(N02)	8(N02)	-(N02)	-(N02)
receive_not_rdy_RSP_F_0_ack	4(A15)	7(A15)	5(A15)	-(A15)	-(A15)	8(A15)	-(A15)	-(A15)
+ receive_not_rdy_RSP_F_1	-(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)
+ receive_not_rdy_RSP_F_1_ack	-(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)
+ unnumbered_ack_frame_RSP_F_0	-(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)
+ unnumbered_ack_frame_RSP_F_1	-(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)
+ disconnect_mode_frame_RSP_F_0	-(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)
+ disconnect_mode_frame_RSP_F_1	-(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)
+ FRMR_frame_RSP_F_0_1	-(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)
go_to_INFO_XFER_state	-	1	1	1	1	1	1	1
go_to_REJECT_state	2	-	2	2	2	2	2	2
go_to_LOCAL_BUSY_state	3	3	-	3	3	3	3	3
go_to_REMOTE_BUSY_state	4	4	4	-	4	4	4	4
go_to_BOTH_BUSY_state	5	5	5	5	-	5	5	5
go_to_REJECT_AND_LBUSY_state	6	6	6	6	6	-	6	6
go_to_REJECT_AND_RBUSY_state	7	7	7	7	7	7	-	7
go_to_REJECT_AND_BBUSY_state	8	8	8	8	8	8	8	-

Output Code	Function
A02	Advance Transmit Window, Acknowledge Receipt and Forward (as described on page L-20). Send Receive Ready Response Frame With F equal value of P bit in the received frame. Reset Reply Timer Tp (as described on page L-21).
A05	Advance Transmit Window and Discard Frame (as described on page L-20). Send Receive Not Ready Response Frame With F equal value of P bit in the received frame. Reset Reply Timer Tp (as described on page L-21).
A08	Advance Transmit Window and Discard Frame (as described on page L-20). Send Reject Response Frame With F equal value of P bit in the received frame. Reset Reply Timer Tp (as described on page L-21).
A10	Advance Transmit Window and Discard Frame (as described on page L-20). Send Receive Ready Response Frame With F equal value of P bit in the received frame. Reset Reply Timer Tp (as described on page L-21).
A15	Advance Transmit Window (as described on page L-20). Reset Reply Timer Tp (as described on page L-21). Start Timer Tn
A17	Advance Transmit Window (as described on page L-20). Send Receive Ready Response Frame With F=1. Reset Reply Timer Tp (as described on page L-21).
A17a	Advance Transmit Window (as described on page L-20). Send Receive Ready Response Frame With F=1. Reset Reply Timer Tp (as described on page L-21). Start Timer Tn.
A19	Advance Transmit Window (as described on page L-20). Send Receive Not Ready Response Frame With F=1. Reset Reply Timer Tp (as described on page L-21).
A19A	Advance Transmit Window (as described on page L-20). Send Receive Not Ready Response Frame With F=1. Reset Reply Timer Tp (as described on page L-21). Start Timer Tn.
A27	Advance Transmit Window and Set Send Sequence (as described on page L-20). Invoke Output UPM (acknowledgement) (as described on page L-21).
A29	Advance Transmit Window and Set Send Sequence (as described on page L-20). Send Receive Ready Response Frame With F=1. Reset Reply Timer Tp (as described on page L-21).
A30	Advance Transmit Window and Set Send Sequence (as described on page L-20). Send Receive Not Ready Response Frame With F=1. Reset Reply Timer Tp (as described on page L-21).
A31	Advance Transmit Window, Acknowledge Receipt and Forward (as described on page L-20). Invoke Output UPM (acknowledgement) (as described on page L-21).
A32	Advance Transmit Window (as described on page L-20). Invoke Output UPM (acknowledgement) (as described on page L-21).
A37	Advance Transmit Window and Discard Frame (as described on page L-20). Invoke Output UPM (null) (as described on page L-21).
A39	Invoke Output UPM (data) (as described on page L-21).
D02	Discard the information field contained in the received frame (see §§ 2.4.4.4). Send Receive Not Ready Response Frame With F equal value of P bit in the received frame.
D05	Discard the information field contained in the received frame (see §§ 2.4.4.4). Send Receive Ready Response Frame With F equal value of P bit in the received frame.
D07	Discard the information field contained in the received frame (see §§ 2.4.4.4). Send Reject Response Frame With F equal value of P bit in the received frame.
D11	Discard the information field contained in the received frame (see §§ 2.4.4.4). Invoke Output UPM (null) (as described on page L-21).
E01	A logically erroneous local conditions that may be reported to a higher layer.
F01	Ignore the received frame (see §§ 2.2.9, 2.3.5.3, 2.4).

Output Code	Function
I03A	If retry limit is exceeded then Report Status (as described on page L-21). Send Set Asynchronous Balanced Mode Command Frame with P = 1. Change SLP_FSM to OPENING state. Else Increment transmission count (see § 2.4.8.4). Send Receive Ready Command Frame With P=1. Initialize poll count. (see § 2.4.5.9). Change SLP_FSM to CHECK_POINT state. See Table L-1 on page L-5. Change SLP_FSM_CHECK_POINT to RECOVER_AND_REJECT state. See Table L-3 on page L-15.
I03B	If retry limit is exceeded then Report Status (as described on page L-21). Send Set Asynchronous Balanced Mode Command Frame with P = 1. Change SLP_FSM to OPENING state. Else Increment transmission count (see § 2.4.8.4). Send Receive Ready Command Frame With P=1. Initialize poll count. (see § 2.4.5.9). Change SLP_FSM to CHECK_POINT state. See Table L-1 on page L-5. Change SLP_FSM_CHECK_POINT to RECOVER_AND_RBUSY state. See Table L-3 on page L-15.
I03C	If retry limit is exceeded then Report Status (as described on page L-21). Send Set Asynchronous Balanced Mode Command Frame with P = 1. Change SLP_FSM to OPENING state. Else Increment transmission count (see § 2.4.8.4). Send Receive Ready Command Frame With P=1. Initialize poll count. (see § 2.4.5.9). Change SLP_FSM to CHECK_POINT state. See Table L-1 on page L-5. Change SLP_FSM_CHECK_POINT to RECOVER_REJECT_RBUSY state. See Table L-3 on page L-15.
I03D	If retry limit is exceeded then Report Status (as described on page L-21). Send Set Asynchronous Balanced Mode Command Frame with P = 1. Change SLP_FSM to OPENING state. Else Increment transmission count (see § 2.4.8.4). Send Receive Ready Command Frame With P=1. Initialize poll count. (see § 2.4.5.9). Change SLP_FSM to CHECK_POINT state. See Table L-1 on page L-5. Change SLP_FSM_CHECK_POINT to CHECK_POINT_RECOVERY state. See Table L-3 on page L-15.
I04A	If retry limit is exceeded then Report Status (as described on page L-21). Send Set Asynchronous Balanced Mode Command Frame with P = 1. Change SLP_FSM to OPENING state. Else Increment transmission count (see § 2.4.8.4). Send Receive Not Ready Command Frame With P=1. Initialize poll count. (see § 2.4.5.9). Change SLP_FSM to CHECK_POINT state. See Table L-1 on page L-5. Change SLP_FSM_CHECK_POINT to RECOVER_AND_BBUSY state. See Table L-3 on page L-15.
I04B	If retry limit is exceeded then Report Status (as described on page L-21). Send Set Asynchronous Balanced Mode Command Frame with P = 1. Change SLP_FSM to OPENING state. Else Increment transmission count (see § 2.4.8.4). Send Receive Not Ready Command Frame With P=1. Initialize poll count. (see § 2.4.5.9). Change SLP_FSM to CHECK_POINT state. See Table L-1 on page L-5. Change SLP_FSM_CHECK_POINT to RECOVER_REJECT_LBUSY state. See Table L-3 on page L-15.
I04C	If retry limit is exceeded then Report Status (as described on page L-21). Send Set Asynchronous Balanced Mode Command Frame with P = 1. Change SLP_FSM to OPENING state. Else Increment transmission count (see § 2.4.8.4). Send Receive Not Ready Command Frame With P=1. Initialize poll count. (see § 2.4.5.9). Change SLP_FSM to CHECK_POINT state. See Table L-1 on page L-5. Change SLP_FSM_CHECK_POINT to RECOVER_REJECT_BBUSY state. See Table L-3 on page L-15.

Output Code	Function
I04D	If retry limit is exceeded then + Report Status (as described on page L-21). + Send Set Asynchronous Balanced Mode Command Frame with P = 1. + Change SLP_FSM to OPENING state. Else Increment transmission count (see § 2.4.8.4). Send Receive Not Ready Command Frame With P=1. Initialize poll count. (see § 2.4.5.9). Change SLP_FSM to CHECK_POINT state. See Table L-1 on page L-5. Change SLP_FSM_CHECK_POINT to RECOVER_AND_LBUSY state. See Table L-3 on page L-15.
K02	Acknowledge receipt (increment Vr by '1') of the received frame and pass the information field to a higher layer (see § 2.4.5.2(1)). Send Receive Ready Response Frame With F equal value of P bit in the received frame.
K04	Acknowledge receipt (increment Vr by '1') of the received frame and pass the information field to a higher layer (see § 2.4.5.2(1)). Invoke Output UPM (acknowledgement) (as described on page L-21).
L01	Assure link operation by transmitting a command frame with P=1 and starting reply timer, Tp (see §§ 2.4.3 and 2.4.5.9). Send Receive Ready Command Frame With P=1. Initialize poll count. (see § 2.4.5.9). Change SLP_FSM to CHECK_POINT state. See Table L-1 on page L-5. Change SLP_FSM_CHECK_POINT to RECOVER_REJECT_BBUSY state. See Table L-3 on page L-15.
L01C	Assure link operation by transmitting a command frame with P=1 and starting reply timer, Tp (see §§ 2.4.3 and 2.4.5.9). Send Receive Ready Command Frame With P=1. Initialize poll count. (see § 2.4.5.9). Change SLP_FSM to CHECK_POINT state. See Table L-1 on page L-5. Change SLP_FSM_CHECK_POINT to RECOVER_AND_RBUSY state. See Table L-3 on page L-15.
L02	Assure link operation by transmitting a command frame with P=1 and starting reply timer, Tp (see §§ 2.4.3 and 2.4.5.9). Send Receive Not Ready Command Frame With P=1. Initialize poll count. (see § 2.4.5.9). Change SLP_FSM to CHECK_POINT state. See Table L-1 on page L-5. Change SLP_FSM_CHECK_POINT to RECOVER_REJECT_BBUSY state. See Table L-3 on page L-15.
L02B	Assure link operation by transmitting a command frame with P=1 and starting reply timer, Tp (see §§ 2.4.3 and 2.4.5.9). Send Receive Not Ready Command Frame With P=1. Initialize poll count. (see § 2.4.5.9). Change SLP_FSM to CHECK_POINT state. See Table L-1 on page L-5. Change SLP_FSM_CHECK_POINT to RECOVER_AND_BBUSY state. See Table L-3 on page L-15.
L03A	Initiate the link disconnection procedure (see § 2.4.4.3). Send Disconnect Command Frame With P=1 Change SLP_FSM to CLOSING state. See Table L-1 on page L-5.
N02	Start Timer Tn
N06	Send Receive Ready Response Frame With F=1.
N06A	Send Receive Ready Response Frame With F=1. Start Timer Tn.
N07	Send Receive Not Ready Response Frame With F=1.
N07A	Send Receive Not Ready Response Frame With F=1. Start Timer Tn.
N09	Invoke Output UPM (null) (as described on page L-21).
R01A	Report Status (as described on page L-21). Change SLP_FSM to INOPERATIVE state. See Table L-1 on page L-5.
R03	Report Status (as described on page L-21). Send Receive Ready Response Frame With F=0.

	Output Code	Function
+	R05	Report Status (as described on page L-21). Send Frame Reject Response Frame With F equal value of P bit in the received command. Start Timer T1 Change SLP_FSM to RECOVERY state.
	R06	Report Status (as described on page L-21). See "Detection of the Idle Channel Condition" on page L-20.
	R08A	Report Status (as described on page L-21). Send Unnumbered Acknowledgement Response Frame With F equal the value of the P bit in the received command. Change SLP_FSM to CLOSED state. See Table L-1 on page L-5.
+ + +	R12A	Report Status (as described on page L-21). Send Set Asynchronous Balanced Mode Command Frame with P = 1. Change SLP_FSM to OPENING state
	R13	Report Status (as described on page L-21). If Response to Command Required (see page L-22). Then Send Receive Not Ready Response Frame With F=1. Else If Convenient Response Opportunity (as described on page L-22). Then Send Receive Not Ready Response Frame With F=0.

	R14	Report Status (as described on page L-21). If Convenient Response Opportunity then (as described on page L-22).
		If information field(s) have been discarded then
		Send Reject Response Frame With F=0.
		Go to REJECT_AND_RBUSY state
		Else
		Send Receive Ready Response Frame With F=0. Else
		If information field(s) have been discarded then
		Send Reject Command Frame With P=0.
		Go to REJECT_AND_RBUSY state
		Else
		Send Receive Ready Command Frame With P=0.

	R14A	Report Status (as described on page L-21). If Convenient Response Opportunity then (as described on page L-22).
		If information field(s) have been discarded then
		Send Reject Response Frame With F=0.
		Go to REJECT state. See Table L-2 on page L-9.
		Else
		Send Receive Ready Response Frame With F=0.
		Go to INFO_XFER state. See Table L-2 on page L-9. Else
		If information field(s) have been discarded then
		Send Reject Command Frame With P=0.
		Go to REJECT state. See Table L-2 on page L-9.
		Else
		Send Receive Ready Command Frame With P=0.
		Go to INFO_XFER state. See Table L-2 on page L-9.

+	R18A	Report Status (as described on page L-21). Send Unnumbered Acknowledgement Response Frame With F equal the value of the P bit in the received command. Set send and receive state variables to 0.
	S03	Set Send Sequence (as described on page L-21). Invoke Output UPM (null) (as described on page L-21).
	S05	Set Send Sequence (as described on page L-21). Send Receive Ready Response Frame With F=1.
	S06	Set Send Sequence (as described on page L-21). Send Receive Not Ready Response Frame With F=1.
	X13	Ignore this input.

SLP_FSM_check_point

Table L-3.

Function: SLP_FSM_check_point Finite State Machine

The states of SLP_FSM_CHECK_POINT are as follows:

1. CHECK_POINT_RECOVER - state (01) is entered by link stations upon expiration of Reply Timer, Tp, following transmissions of an appropriate Supervisory command frame with 'P = 1' (see §§ 2.3.5.2(2) and 2.4.5.9).
2. RECOVER_AND_REJECT - state (02) is a composite of the CHECK_POINT RECOVER state (01) of SLP_FSM_CHECK_POINT and the REJECT state (02) of SLP_FSM_OPENED.
3. RECOVER_AND_LBUSY - state (03) is a composite of the SLP_FSM_CHECK_POINT RECOVER state (01) and the LOCAL_BUSY state (03) of SLP_FSM_OPENED (see §§ 2.3.5.1, 2.4.5.8 and 2.4.5.9).
4. RECOVER_AND_RBUSY - state (04) is a composite of the Link Layer LAPB_FSM_CHECK_POINT RECOVER state (01) and the REMOTE_BUSY state (04) of SLP_FSM_OPENED (see §§ 2.3.5.1, 2.4.5.8 and 2.4.5.9).
5. RECOVER_AND_BBUSY - state (05) is a composite of the SLP_FSM_CHECK_POINT RECOVER state (01) and the BOTH_BUSY state (05) of SLP_FSM_OPENED (see §§ 2.3.5.1, 2.4.5.8 and 2.4.5.9).
6. RECOVER_REJECT_LBUSY - state (06) is a composite of the SLP_FSM_CHECK_POINT RECOVER state (01), the REJECT state (02) of SLP_FSM_OPENED, and the LOCAL_BUSY state (03) of SLP_FSM_OPENED.
7. RECOVER_REJECT_RBUSY - state (07) is a composite of the SLP_FSM_CHECK_POINT RECOVER state (01), the REJECT state (02) of SLP_FSM_OPENED, and the REMOTE_BUSY state (04) of SLP_FSM_OPENED.
8. RECOVER_REJECT_BBUSY - state (08) is a composite of the LAPB_FSM_CHECK_POINT RECOVER state (01), the REJECT state (02) of SLP_FSM_OPENED, and the BOTH_BUSY state (05) of SLP_FSM_OPENED.

Input: Inputs that are common to this FSM and the other two SLP FSMs are described in "LAPB Single Link Procedure" on page L-2.

When a finite state machine must change the state of SLP_FSM_CHECK_POINT the following inputs are used. Output codes suffixed by a letter of the alphabet generally use these inputs.

- go_to_CHECK_POINT_RECOVER
- go_to_RECOVER_AND_REJECT
- go_to_RECOVER_AND_LBUSY
- go_to_RECOVER_AND_RBUSY
- go_to_RECOVER_AND_BBUSY
- go_to_RECOVER_REJECT_LBUSY
- go_to_RECOVER_REJECT_RBUSY
- go_to_RECOVER_REJECT_BBUSY

Inputs	States: check point recover	recover and reject	recover and lbusy	recover and rbusy	recover and bbusy	recover reject lbusy	recover reject rbusy	recover reject bbusy
	1	2	3	4	5	6	7	8
media_is_operational	-(E01)	-(E01)	-(E01)	-(E01)	-(E01)	-(E01)	-(E01)	-(E01)
start_the_link	-(E01)	-(E01)	-(E01)	-(E01)	-(E01)	-(E01)	-(E01)	-(E01)
stop_the_link	-(R01)	-(R01)	-(R01)	-(R01)	-(R01)	-(R01)	-(R01)	-(R01)
media_is_inoperative	-(R01A)	1(R01A)	1(R01A)	1(R01A)	1(R01A)	1(R01A)	1(R01A)	1(R01A)
out_of_resources	3(R13)	6(R13)	-(E01)	5(R13)	-(E01)	-(E01)	8(R13)	-(E01)
resources_available	-(E01)	-(E01)	1(R03)	-(E01)	4(R03)	2(R03)	-(E01)	7(R03)
+ reply_timer_Tp_expired	-(I03)	-(I03)	-(I04)	-(I03)	-(I04)	-(I04)	-(I03)	-(I04)
query_timer_Tn_expired	-(L01)	-(L01)	-(L02)	-(L01)	-(L02)	-(L02)	-(L01)	-(L02)
illegal_frame	-(R05)	1(R05)	1(R05)	1(R05)	1(R05)	1(R05)	1(R05)	1(R05)
invalid_frame	-(F01)	-(F01)	-(F01)	-(F01)	-(F01)	-(F01)	-(F01)	-(F01)
receive_link_channel_is_idle	-(R06)	-(R06)	-(R06)	-(R06)	-(R06)	-(R06)	-(R06)	-(R06)
transmit_link_channel_is_ready	-(T03)	-(T03)	-(T03)	-(T03)	-(T03)	-(T03)	-(T03)	-(T03)
send_data	-(A39)	-(A39)	-(A39)	-(A39)	-(A39)	-(A39)	-(A39)	-(A39)
I_frame_CMD_P_0_inseq	-(K02)	1(K02)	-(D02)	-(K02)	-(D02)	3(D02)	4(K02)	5(D02)
I_frame_CMD_P_0_ack_inseq	-(A02)	1(A02)	-(A05)	-(A02)	-(A05)	3(A05)	4(A02)	5(A05)
I_frame_CMD_P_1_inseq	-(K02)	1(K02)	-(D02)	-(K02)	-(D02)	3(D02)	4(K02)	5(D02)
I_frame_CMD_P_1_ack_inseq	-(A02)	1(A02)	-(A05)	-(A02)	-(A05)	3(A05)	4(A02)	5(A05)
I_frame_CMD_P_0_out_of_seq	2(D07)	-(D05)	-(D02)	7(D07)	-(D02)	-(D02)	-(D05)	-(D02)
I_frame_CMD_P_0_ack_out_of_seq	2(A08)	-(A10)	-(A05)	7(A08)	-(A05)	-(A05)	-(A10)	-(A05)
I_frame_CMD_P_1_out_of_seq	2(D07)	-(D05)	-(D02)	7(D07)	-(D02)	-(D02)	-(D05)	-(D02)
I_frame_CMD_P_1_ack_out_of_seq	2(A08)	-(A10)	-(A05)	7(A08)	-(A05)	-(A05)	-(A10)	-(A05)
receive_rdy_frame_CMD_P_0	-(X13)	-(X13)	-(X13)	1(X13)	3(X13)	-(X13)	2(X13)	6(X13)
receive_rdy_frame_CMD_P_0_ack	-(A13)	-(A13)	-(A13)	1(A13)	3(A13)	-(A13)	2(A13)	6(A13)
receive_rdy_frame_CMD_P_1	-(N06)	-(N06)	-(N07)	1(N06)	3(N07)	-(N07)	2(N06)	6(N07)
receive_rdy_frame_CMD_P_1_ack	-(A17)	-(A17)	(A19)	1(A17)	3(A19)	(A19)	2(A17)	6(A19)
reject_frame_CMD_P_0	-(S03)	-(S03)	-(S03)	1(S03)	3(S03)	-(S03)	2(S03)	6(S03)
reject_frame_CMD_P_0_ack	-(A27)	-(A27)	-(A27)	1(A27)	3(A27)	-(A27)	2(A27)	6(A27)
reject_frame_CMD_P_1	-(S05)	-(S05)	-(S06)	1(S05)	3(S06)	-(S06)	2(S05)	6(S06)
reject_frame_CMD_P_1_ack	-(A29)	-(A29)	-(A30)	1(A29)	3(A30)	-(A30)	2(A29)	6(A30)
receive_not_rdy_CMD_P_0	4(N02)	7(N02)	5(N02)	-(N02)	-(N02)	8(N02)	-(N02)	-(N02)
receive_not_rdy_CMD_P_0_ack	4(A15)	7(A15)	5(A15)	-(A15)	-(A15)	8(A15)	-(A15)	-(A15)
receive_not_rdy_CMD_P_1	4(N06A)	7(N06A)	5(N07A)	-(N06A)	-(N07A)	8(N07A)	-(N06A)	-(N07A)
receive_not_rdy_CMD_P_1_ack	4(A17A)	7(A17A)	5(A19A)	-(A17A)	-(A19A)	8(A19A)	-(A17A)	-(A19A)
SABM_frame_CMD_P_0	-(R18A)	1(R18A)	1(R18A)	1(R18A)	1(R18A)	1(R18A)	1(R18A)	1(R18A)
SABM_frame_CMD_P_1	-(R18A)	1(R18A)	1(R18A)	1(R18A)	1(R18A)	1(R18A)	1(R18A)	1(R18A)
disconnect_frame_CMD_P_0	-(R08A)	1(R08A)	1(R08A)	1(R08A)	1(R08A)	1(R08A)	1(R08A)	1(R08A)
disconnect_frame_CMD_P_1	-(R08A)	1(R08A)	1(R08A)	1(R08A)	1(R08A)	1(R08A)	1(R08A)	1(R08A)
receive_rdy_frame_RSP_F_0	-(X13)	-(X13)	-(X13)	1(X13)	3(X13)	-(X13)	2(X13)	6(X13)
receive_rdy_frame_RSP_F_0_ack	-(A13)	-(A13)	-(A13)	1(A13)	3(A13)	-(A13)	2(A13)	6(A13)
receive_rdy_frame_RSP_F_1	-(X07A)	1(X07B)	1(X07C)	1(X07A)	1(X07C)	1(X07D)	1(X07B)	1(X07D)
receive_rdy_frame_RSP_F_1_ack	-(A35A)	1(A35B)	1(A35C)	1(A35A)	1(A35C)	1(A35D)	1(A35B)	1(A35D)
reject_frame_RSP_F_0	-(S03)	-(S03)	-(S03)	1(S03)	3(S03)	-(S03)	2(S03)	6(S03)
reject_frame_RSP_F_0_ack	-(A34)	-(A34)	-(A34)	1(A34)	3(A34)	-(A34)	2(A34)	6(A34)
reject_frame_RSP_F_1	-(S08A)	1(S08B)	1(S08C)	1(S08A)	1(S08C)	1(S09C)	1(S08B)	1(S09C)
reject_frame_RSP_F_1_ack	-(A36A)	1(A36B)	1(A36C)	1(A36A)	1(A36C)	1(X08C)	1(A36B)	1(X08C)
receive_not_rdy_RSP_F_0	4(X13)	7(X13)	5(X13)	-(X13)	-(X13)	8(X13)	-(X13)	-(X13)
receive_not_rdy_RSP_F_0_ack	4(A13)	7(A13)	5(A13)	-(A13)	-(A13)	8(A13)	-(A13)	-(A13)
receive_not_rdy_RSP_F_1	-(N02A)	1(N02B)	1(X02B)	1(N02A)	-(X02B)	1(N02C)	1(N02B)	1(N02C)
receive_not_rdy_RSP_F_1_ack	-(A15A)	1(A24B)	1(A15B)	1(A15A)	1(A15B)	1(A24C)	1(A24B)	1(A24C)
+ unumbered_ack_frame_RSP_F_0	-(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)
+ unumbered_ack_frame_RSP_F_1	-(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)
+ disconnect_mode_frame_RSP_F_0	-(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)
+ disconnect_mode_frame_RSP_F_1	-(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)
+ FRMR_frame_RSP_F_0_1	-(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)	1(R12A)
go_to_CHECK_POINT_RECOVER	-	1	1	1	1	1	1	1
go_to_RECOVER_AND_REJECT	2	-	2	2	2	2	2	2
go_to_RECOVER_AND_LBUSY	3	3	-	3	3	3	3	3
go_to_RECOVER_AND_RBUSY	4	4	4	-	4	4	4	4
go_to_RECOVER_AND_BBUSY	5	5	5	5	-	5	5	5
go_to_RECOVER_REJECT_LBUSY	6	6	6	6	6	-	6	6
go_to_RECOVER_REJECT_RBUSY	7	7	7	7	7	7	-	7
go_to_RECOVER_REJECT_BBUSY	8	8	8	8	8	8	8	-

Output Code	Function
A02	Advance Transmit Window, Acknowledge Receipt and Forward (as described on page L-20). Send Receive Ready Response Frame With F equal value of P bit in the received frame.
A05	Advance Transmit Window and Discard Frame (as described on page L-20). Send Receive Not Ready Response Frame With F equal value of P bit in the received frame.
A08	Advance Transmit Window and Discard Frame (as described on page L-20). Send Reject Response Frame With F equal value of P bit in the received frame.
A10	Advance Transmit Window and Discard Frame (as described on page L-20). Send Receive Ready Response Frame With F equal value of P bit in the received frame.
A13	Advance Transmit Window (as described on page L-20).
A15	Advance Transmit Window (as described on page L-20). Start Timer Tn
A15A	Advance Transmit Window (as described on page L-20). Reset Reply Timer Tp (as described on page L-21). Start Timer Tn Change SLP_FSM to OPENED state. See Table L-1 on page L-5. Change SLP_FSM_OPENED to REMOTE_BUSY state. See Table L-2 on page L-9.
A15B	Advance Transmit Window (as described on page L-20). Reset Reply Timer Tp (as described on page L-21). Start Timer Tn Change SLP_FSM to OPENED state. See Table L-1 on page L-5. Change SLP_FSM_OPENED to BOTH_BUSY state. See Table L-2 on page L-9.
A17	Advance Transmit Window (as described on page L-20). Send Receive Ready Response Frame With F=1.
A17A	Advance Transmit Window (as described on page L-20). Send Receive Ready Response Frame With F=1. Start Timer Tn.
A19	Advance Transmit Window (as described on page L-20). Send Receive Not Ready Response Frame With F=1.
A19A	Advance Transmit Window (as described on page L-20). Send Receive Not Ready Response Frame With F=1. Start Timer Tn.
A24B	Advance Transmit Window (as described on page L-20). Reset Reply Timer Tp (as described on page L-21). Start Timer Tn Change SLP_FSM to OPENED state. See Table L-1 on page L-5. Change SLP_FSM_OPENED to REJECT_AND_RBUSY state. See Table L-2 on page L-9.
A24C	Advance Transmit Window (as described on page L-20). Reset Reply Timer Tp (as described on page L-21). Start Timer Tn Change SLP_FSM to OPENED state. See Table L-1 on page L-5. Change SLP_FSM_OPENED to REJECT_AND_BBUSY state. See Table L-2 on page L-9.
A27	Advance Transmit Window and Set Send Sequence (as described on page L-20).
A29	Advance Transmit Window and Set Send Sequence (as described on page L-20). Send Receive Ready Response Frame With F=1.
A30	Advance Transmit Window and Set Send Sequence (as described on page L-20). Send Receive Not Ready Response Frame With F=1.
A34	Advance Transmit Window and Set Send Sequence (as described on page L-20).
A35A	Advance Transmit Window (as described on page L-20). Invoke Output UPM (null) (as described on page L-21). Change SLP_FSM to OPENED state. See Table L-1 on page L-5. Change SLP_FSM_OPENED to INFO_XFER state. See Table L-2 on page L-9.
A35B	Advance Transmit Window (as described on page L-20). Invoke Output UPM (null) (as described on page L-21). Change SLP_FSM to OPENED state. See Table L-1 on page L-5. Change SLP_FSM_OPENED to REJECT state. See Table L-2 on page L-9.
A35C	Advance Transmit Window (as described on page L-20). Invoke Output UPM (null) (as described on page L-21). Change SLP_FSM to OPENED state. See Table L-1 on page L-5. Change SLP_FSM_OPENED to LOCAL_BUSY state. See Table L-2 on page L-9.
A35D	Advance Transmit Window (as described on page L-20). Invoke Output UPM (null) (as described on page L-21). Change SLP_FSM to OPENED state. See Table L-1 on page L-5. Change SLP_FSM_OPENED to REJECT_AND_LBUSY state. See Table L-2 on page L-9.
A36A	Advance Transmit Window and Set Send Sequence (as described on page L-20). Invoke Output UPM (null) (as described on page L-21). Change SLP_FSM to OPENED state. See Table L-1 on page L-5. Change SLP_FSM_OPENED to INFO_XFER state. See Table L-2 on page L-9.

Output Code	Function
A36B	Advance Transmit Window and Set Send Sequence (as described on page L-20). Invoke Output UPM (null) (as described on page L-21). Change SLP_FSM to OPENED state. See Table L-1 on page L-5. Change LAPB_FSM_OPENED to REJECT state. See Table L-2 on page L-9.
A36C	Advance Transmit Window and Set Send Sequence (as described on page L-20). Invoke Output UPM (null) (as described on page L-21). Change SLP_FSM to OPENED state. See Table L-1 on page L-5. Change SLP_FSM_OPENED to LOCAL_BUSY state. See Table L-2 on page L-9.
a39	Invoke Output UPM (data) (as described on page L-21).
D02	Discard the information field contained in the received frame (see §§ 2.4.4.4). Send Receive Not Ready Response Frame With F equal value of P bit in the received frame.
D05	Discard the information field contained in the received frame (see §§ 2.4.4.4). Send Receive Ready Response Frame With F equal value of P bit in the received frame.
D07	Discard the information field contained in the received frame (see §§ 2.4.4.4). Send Reject Response Frame With F equal value of P bit in the received frame.
E01	A logically erroneous local conditions that may be reported to a higher layer.
F01	Ignore the received frame (see §§ 2.2.9, 2.3.5.3, 2.4).
I03	If retry limit is exceeded then Report Status (as described on page L-21). Send Set Asynchronous Balanced Mode Command Frame with P = 1. Change SLP_FSM to OPENING state. Go to CHECK_POINT_RECOVER state Else Send Receive Ready Command Frame With P=1. Increment poll count. (see § 2.4.5.9).
I04	If retry limit is exceeded then Report Status (as described on page L-21). Send Set Asynchronous Balanced Mode Command Frame with P = 1. Change SLP_FSM to OPENING state. Go to CHECK_POINT_RECOVER state Else Send Receive Not Ready Command Frame With P=1. Increment poll count. (see § 2.4.5.9).
K02	Acknowledge receipt (increment Vr by '1') of the received frame and pass the information field to a higher layer (see § 2.4.5.2(1)). Send Receive Ready Response Frame With F equal value of P bit in the received frame.
L01	Assure link operation by transmitting a command frame with P=1 and starting reply timer, Tp (see §§ 2.4.3 and 2.4.5.9). Send Receive Ready Response Frame With F=1.
L02	Assure link operation by transmitting a command frame with P=1 and starting reply timer, Tp (see §§ 2.4.3 and 2.4.5.9). Send Receive Not Ready Command Frame With P=1.
N02	Start Timer Tn
N02A	Start Timer Tn Reset Reply Timer Tp (as described on page L-21). Change SLP_FSM to OPENED state. See Table L-1 on page L-5. Change SLP_FSM_OPENED to REMOTE_BUSY state. See Table L-2 on page L-9.
N02B	Start Timer Tn Reset Reply Timer Tp (as described on page L-21). Change SLP_FSM to OPENED state. See Table L-1 on page L-5. Change SLP_FSM_OPENED to REJECT_AND_RBUSY state. See Table L-2 on page L-9.
N02C	Start Timer Tn Reset Reply Timer Tp (as described on page L-21). Change SLP_FSM to OPENED state. See Table L-1 on page L-5. Change SLP_FSM_OPENED to REJECT_AND_BBUSY state. See Table L-2 on page L-9.
N06	Send Receive Ready Response Frame With F=1.
N06A	Send Receive Ready Response Frame With F=1. Start Timer Tn.

Output Code	Function
N07	Send Receive Not Ready Response Frame With F=1.
N07A	Send Receive Not Ready Response Frame With F=1. Start Timer Tn.
R01	Report Status (as described on page L-21)
R01A	Report Status (as described on page L-21) Change SLP_FSM to INOPERATIVE state. See Table L-1 on page L-5.
R03	Report Status (as described on page L-21) Send Receive Ready Response Frame With F=0.
R05	Report Status (as described on page L-21) Send Frame Reject Response Frame With F equal value of P bit in the received command. Change SLP_FSM to RECOVERY state. See Table L-1 on page L-5.
R06	Report Status (as described on page L-21) See "Detection of the Idle Channel Condition" on page L-20.
R08A	Report Status (as described on page L-21) Send Unnumbered Acknowledgement Response Frame With F equal the value of the P bit in the received command. Change SLP_FSM to CLOSED state. See Table L-1 on page L-5.
+ R12A	Report Status (as described on page L-21) Send Set Asynchronous Balanced Mode Command Frame with P = 1. Change SLP_FSM to Opening State
R13	Report Status (as described on page L-21) If Convenient Response Opportunity (as described on page L-22). Then Send Receive Not Ready Response Frame With F=0. Else If Response to Command Required (as described on page L-22). Then Send Receive Not Ready Response Frame With F=1.
+ R18A	Report Status (as described on page L-21). Send Unnumbered Acknowledgement Response Frame With F equal the value of the P bit in the received command. Change SLP_FSM to OPENED state. See Table L-1 on page L-5.
S03	Set Send Sequence (as described on page L-21).
S05	Set Send Sequence (as described on page L-21). Send Receive Ready Response Frame With F=1.
S06	Set Send Sequence (as described on page L-21). Send Receive Not Ready Response Frame With F=1.
S08A	Set Send Sequence (as described on page L-21). Invoke Output UPM (null) (as described on page L-21). Change SLP_FSM to OPENED state. See Table L-1 on page L-5.
S08B	Set Send Sequence (as described on page L-21). Invoke Output UPM (null) (as described on page L-21). Change SLP_FSM to OPENED state. See Table L-1 on page L-5. Change SLP_FSM_OPENED to REJECT state. See Table L-2 on page L-9.
S08C	Set Send Sequence (as described on page L-21). Invoke Output UPM (null) (as described on page L-21). Change SLP_FSM to OPENED state. See Table L-1 on page L-5. Change SLP_FSM_OPENED to LOCAL_BUSY state. See Table L-2 on page L-9.
S09C	Set Send Sequence (as described on page L-21). Invoke Output UPM (null) (as described on page L-21). Change SLP_FSM to OPENED state. See Table L-1 on page L-5. Change SLP_FSM_OPENED to REJECT_AND_LBUSY state. See Table L-2 on page L-9.
T03	Start reply timer, Tp, if it is not already running (see § 2.4.8).
X02B	Start Timer Tn Reset Reply Timer Tp (as described on page L-21). Change SLP_FSM to OPENED state. See Table L-1 on page L-5. Change SLP_FSM_OPENED to BOTH_BUSY state. See Table L-2 on page L-9.
X07A	Invoke Output UPM (null) (as described on page L-21). Change SLP_FSM to OPENED state. See Table L-1 on page L-5.
X07B	Invoke Output UPM (null) (as described on page L-21). Change SLP_FSM to OPENED state. See Table L-1 on page L-5. Change SLP_FSM_OPENED to REJECT state. See Table L-2 on page L-9.
X07C	Invoke Output UPM (null) (as described on page L-21). Change SLP_FSM to OPENED state. See Table L-1 on page L-5. Change SLP_FSM_OPENED to LOCAL_BUSY state. See Table L-2 on page L-9.
X07D	Invoke Output UPM (null) (as described on page L-21). Change SLP_FSM to OPENED state. See Table L-1 on page L-5. Change SLP_FSM_OPENED to REJECT_AND_LBUSY state. See Table L-2 on page L-9.

Output Code	Function
X08C	Advance Transmit Window and Set Send Sequence (as described on page L-21). Invoke Output UPM (null) (as described on page L-22). Change SLP_FSM to OPENED state. See Table L-1 on page L-6. Change SLP_FSM_OPENED to REJECT_AND_LBUSY state. See Table L-2 on page L-10.
X13	Ignore this input.

ADVANCE_XMIT_WIN

FUNCTION: Advance Transmit Window

Advance the lower transmit window edge to the Nr contained in the received frame (see § 2.4.5.5).

ADVANCE_XMIT_WIN_ACK_REC_FOR

FUNCTION: Advance Transmit Window, Acknowledge Receipt and Forward

Advance the lower transmit window edge to the Nr contained in the received frame, acknowledge receipt (increment Vr by '1' .) of the received frame and pass the information field to a higher layer (see § 2.4.5.9).

ADVANCE_XMIT_WIN_XET_SND_SEQ

FUNCTION: Advance Transmit Window and Set Send Sequence

Advance the lower transmit window edge to the Nr contained in the received frame and set the send sequence variable (Vs) equal to the value of Nr contained in the received frame (see §§ 2.4.5.5 and 2.4.5.6).

ADVANCE_XMIT_WIN_AND_DISC_FRM

FUNCTION: Advance Transmit Window and Discard Frame

Advance the lower transmit window edge to the Nr contained in the received frame and discard the information field (see §§ 2.4.5.2(2) and 2.4.5.5).

DETECT_IDLE_CHANNEL

FUNCTION: Detection of the Idle Channel Condition

Detection of the Idle Channel condition may be either ignored; or, if a flag sequence is not received within a period of time (Ti), considered as an event causing a change to the disconnected phase (see § 2.2.12.2).

SET_REPLY_TIMER

FUNCTION: Reset Reply Timer Tp

If Unacknowleged I-Frames Remain, Start Tp -
Upon correct receipt of a frame acknowledging some previously transmitted I-frames(s) (containing an Nr that is higher than the last Nr received), DTEs reset (stop) Reply Timer Tp and if additional unacknowledged I-frames(s) are still outstanding they restart Reply Timer Tp.

SET_SND_SEQ

FUNCTION: Set Send Sequence.

Set the send sequence variable (Vs) equal to the value of Nr contained in the received frame (see §-2.4.5.5).

OUTPUT_UPM

FUNCTION: Output_UPM

The Output Undefined Protocol Machine (UPM) is invoked from SLP_FSM, SLP_FSM_OPENED and SLP_FSM_CHECKPOINT protocol machines to initiate and manage transmissions on the output link channel. Functions of the output_UPM include, but are not necessarily limited to:

1. maintenance of a link outbound queue;
2. maintenance of a retransmission queue;
3. utilization of the outbound link channel;
4. initialization of the transmission count variable;

Parameters passed to the output_UPM include:

1. (Acknowledgement) - denoting receipt of acknowledgment for one or more previously transmitted I-frames and advancement of the lower transmit window edge;
2. (Data) - denoting receipt of data to be transmitted from a higher layer user; and
3. (Null) - denoting occurrence of the output link channel idle event.

REPORT_STATUS

FUNCTION: Report Status

A higher layer may be informed of the event/condition/state using DTE specific internal signalling mechanisms (see §§ 2.4.3.1, and 2.4.4.1, and 2.4.4.3).

CONVENIENT_RESP_OPPORTUNITY

FUNCTION: Convenient Response Opportunity

When at a convenient respond opportunity, for example, the DTE received several I frames and should send an Nr to the DCE. It may send the Nr within an I frame or supervisory frame that it has a need to send to the DCE. The transmission must occur prior to the expiration of T1.

RESPONSE_TO_CMD_REQUIRED

FUNCTION: Response To Command Required

When a response to a command received with 'P=1' is required, a response with F=1 must be sent at the first opportunity.

PREPARED_TO_CONT_OPERATION

FUNCTION: Prepared To Continue Operation

When prepared to continue operation with, or following, (re)initialization of the SLP DTE/DCE interface.

ENABLED_AND_PREPARED

FUNCTION: Enabled And Prepared

When the Single Link Procedure (SLP) is enabled and prepared to (re)initialize the SLP DTE/DCE interface and support the transfer of information.

Appendix M. Description of the Enhanced Logical Link Control - (ELLC) Procedures

The formats and protocols described in this appendix are adaptations of Asynchronous Balanced Mode (ABM) formats defined for HDLC and the X.25 Link Access Procedure - Balanced (LAPB) elements of procedure expanded to include an adaptation of the checksum data integrity mechanism defined for IS-8073 (Open Systems Interconnection Transport Protocol Specification in ISO/TC-97/SC-6-N3240) dated September 1984.

M.1 Functional Overview

M.1.1 Architecture

Architecture to meet SNA quality of service requirements in packet-switched data network environments:

- defines a Connection_Type_Indicator (CTI) within the Call_User_Data field of X.25 CALL_REQUEST packets to distinguish between initial connection requests and connection recovery requests for ELLC;
- defines a Connection_Identifier (CID) field in Call Set-up packets to carry Link_Connection_Identification information between adjacent link stations;
- defines LPDU headers for use the User_Data field of X.25 DATA packets and DATA packet sequences to perform sequenced transfers of BTUs between link stations in adjacent SNA nodes that include:
  - a two-byte address field;
  - an extended (two-byte) control field;
  - a two-byte checksum field; and,
- defines recoverable call clearing, virtual circuit resetting and interface restarting cause codes together with link connection recovery procedures.

M.1.2 Link Connection Service

With a one-for-one correspondence between DLC.X25 link connections and X.25 virtual circuits, link connection services required for logical link control, to meet quality of service enhancement objectives in PSDN environments, are provided by adaptation of existing X.25 Packet Layer call set-up and clearing procedures.

M.1.3 Link Connection Identification

Since a one-for-one correspondence exists between X.25 logical channels and LLC link stations, X.25 logical channel identifiers (LCIs) can be used by LLC to route DATA packets to the appropriate link station. DLC.X25 link connection identification requirements are satisfied by correlating X.25 Calling DTE Addresses, concatenated with a Connection Identifier carried in CALL_REQUEST packets when parallel virtual calls are employed between DTEs, with X.25 logical channel identifiers.

M.1.3.1 Permanent Virtual Circuit Services

The relationship between DLC.X25 link connections employing permanent virtual circuits and X.25 logical channel identifiers are fixed by bilateral agreement between communicating link stations; therefore, X.25 logical channel identifiers can suffice for both LLC routing and error recovery functions, in this environment.

M.1.3.2 Switched_Virtual_Circuit (Virtual Call) Services

Since X.25 logical channel identifiers for switched virtual circuits are dynamically assigned at call set-up time, they suffice only for the LLC routing function; and, are correlated to X.25 Calling DTE Addresses, concatenated with the Connection Identifier as required, for use in error situations requiring re-connection procedures.

M.1.4 Error Detection and Recovery

LLC error detection and recovery requirements are satisfied by ELLC which, when selected, provides mechanisms to detect, and procedures to attempt recovery from, the loss, duplication and/or corruption of LPDUs by underlying network services. ELLC incorporates sequence numbering and validity checking mechanisms, as well as circuit assurance procedures.

M.1.4.1 Sequence Numbering

ELLC formats and protocols provide for the sequenced (modulo 128) transfer of information LPDUs, together with LPDU acknowledgment and retransmission recovery procedures to guard against the loss or duplication of LPDUs, or both.

M.1.4.2 Validity Checking

ELLC also employs a checksum mechanism to detect LPDUs that have been corrupted by underlying network services and to insure the integrity of BTUs delivered to higher layer using protocols.

M.1.4.3 Circuit Assurance

ELLC circuit assurance capability defines recoverable error conditions reported by PSDNs through CLEAR_, RESET_ and RESTART_REQUEST packets, as well as procedures for ascertaining and performing actual circuit recoverability.

M.2 Scope and Field of Application

The Logical Link Control (LLC) procedure is described as the element used to enhance the quality of service exhibited to higher layer SNA users by the underlying network services in supporting the transfer of information between adjacent SNA nodes in PSDN environments.

The procedure uses the principles and terminology of the High Layer Data Link Control (HDLC) procedures specified by the International Organization for Standardization (ISO).

The transmission facility is duplex.

Compatibility of operation with the ISO balanced class of procedure (Class BA, options 1, 2, 8 and 12) is achieved using the provisions found in this specification.

M.3 Link Protocol Data Unit Structure

All transfers across ELLC link connections are in LLC Protocol Data Units (LPDUs) conforming to one of the formats shown in Figure M-1 which are contained in the User Data field of X.25 DATA packets or DATA packet sequences.

Octet	1	2	3	4	5	6
	Address		Control		PDUCS	
	A 16-bits		C 16-bits		X	Y
					2 Octets*	

Supervisory and Unnumbered Format

Octet	1	2	3	4	5	6	7	6+N
	Address		Control		PDUCS		I-Field	
	A 16-bits		C 16-bits		X	Y	I N-Octets*	
					2 Octets*			

Information Format

PDUCS = Protocol Data Unit Checking Sequence - (Checksum)
* an Octet is an 8-bit byte.

Figure M-1. LPDU Formats: Supervisory and Unnumbered versus Information

M.3.1 Address (A) Field

The LPDU address is a two-octet (16-bit) field which has the format shown in Figure M-2. The A field is positioned as shown in Figure M-1 on page M-3 and coded as described in "Procedure for Addressing" on page M-15.

Octet 1	Octet 2	
Address Bits 1 - - - - - - - -	- - - - - - 15	16
ADDRESS 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0	C/R x

where:

ADDRESS - is reserved and set to zeroes; and

x - is the LPDU command/response (C/R) indicator which is set to:
'0' in command LPDUs; and,
'1' in response LPDUs.

Figure M-2. LPDU Address Field Format

M.3.2 Control (C) Field

The C field is two octets positioned as shown in Figure M-1 on page M-3 whose content is described in "LPDU Formats and State Variables" on page M-5.

M.3.3 Information (I) Field

The I-field of LPDUs transmitted and received by link stations contain an SNA Path Information Unit (PIU) consisting of an integral number of octets (8-bit bytes).

Note:

LPDUs containing other than an integral number of octets may be ignored at the physical or link layer.

See "LLC_Protocol_Data_Unit_Reject (LPDUR) Response" on page M-10 and "Maximum Number of Bytes in an IPDU - (LN1)" on page M-24 with regard to the maximum information field length.

M.3.4 Protocol_Data_Unit_Checking_Sequence (PDUCS) Field

The PDUCS field is two octets positioned as shown in Figure M-1 on page M-3 whose content is described in "Protocol_Data_Unit_Checking_Sequence (PDUCS)" on page M-13.

M.3.5 Order of Transmission

Address, control, sequence number, Protocol Data Unit Checking Sequence (PDUCS) and information octets are transmitted in ascending octet number order as indicated in Figure M-1 on page M-3 low order bit first.

M.3.6 Invalid LPDUs

LPDUs having fewer than forty-eight bits (six octets) are invalid.

M.3.7 Link Channel States

A link channel is defined as the means of transmission for one direction.

M.3.7.1 Active State

A link channel is in an active condition when the link station is actively transmitting an LPDU.

M.3.7.2 Idle State

A link channel is defined to be in an idle condition when the link station fails to receive an LPDU for a system specified period of time.

M.4 Elements of Procedure

The elements of procedure are defined in terms of actions that occur on receipt of commands or responses or the occurrence of events, at ELLC link stations.

The elements of procedure specified here contain a selection of commands and responses relevant to the ELLC link connection and system configuration described in "Scope and Field of Application" on page M-3.

A procedure derived from these elements of procedure is described in "Description of the Procedure" on page M-15. Together "Link Protocol Data Unit Structure" on page M-3 and "Elements of Procedure" form the general requirements for proper management of link connections between ELLC link stations in adjacent nodes.

M.4.1 LPDU Formats and State Variables

The various LPDU formats and link station state variables used for ELLC are described under "Control (C) Field Formats" and "Control Field Parameters" on page M-6.

M.4.1.1 Control (C) Field Formats

The C field contains a command or a response, and sequence numbers, where applicable. Three LPDU C-field formats as shown in Figure M-3 on page M-6 are defined for use, which include:

- IPDUs - to perform sequenced information transfers;
- SPDUs - to perform numbered supervisory functions; and
- UPDUs - to perform unnumbered control functions.

Control field bits	Second Octet 8 7 6 5 4 3 2	1	First Octet 8 7 6	5	4 3	2	1
Information (IPDU)	LNr	P	LNs				0
Supervisory (SPDU)	LNr	P/F	x x x	x	S S	0	1
Unnumbered (UPDU)	000	P/F	M M M	0	M M	1	1

LNs = transmitter send sequence number (bit 2 = low order bit).
LNr = transmitter receive sequence number (bit 2 = low order bit).
S = supervisory function bit.
M = modifier function bit.
P/F = poll (P) bit in command frames or final (F) bit in response frames (1 = Poll/Final).

Figure M-3. LPDU Control Field Formats

Information_Protocol_Data_Unit - IPDU: used to perform sequenced information transfers. Except as otherwise specified (i.e., LPDUR, LTEST, LXID) it is the only LPDU that may contain an information field. The functions of LNs, LNr and P/F are independent; i.e., each IPDU has an LNs, and an LNr which may or may not acknowledge additional IPDUs received by the ELLC link station transmitting the LNr, and a P/F bit.

Supervisory_Protocol_Data_Unit - SPDU: used to perform link supervisory control functions such as acknowledging IPDUs, requesting retransmission of IPDUs, and requesting temporary suspension of IPDU transmission.

Unnumbered_Protocol_Data_Unit - UPDU: used to provide additional link control functions. This format contains no sequence numbers.

M.4.1.2 Control Field Parameters

Parameters associated with the control field formats include a modulus (m), LPDU variables and sequence numbers.

Modulus - 'm': IPDUs are sequentially numbered and may have the value 'LNs=0' through 'LNs=m minus one' (where 'm' is the modulus of the sequence numbers). 'm' is equal to '128' and the sequence numbers cycle through the entire range '0' to '127', inclusive.

State Variables and Sequence Numbers

- Link Send State Variable (LVs)

  LVs denotes the sequence number of the next in-sequence IPDU to be transferred across the link connection. LVs can take on the value '0' through 'm minus one'. The value of LVs is incremented by one with each successive IPDU transferred but at originating link stations cannot exceed LNr of the last received IPDU or SPDU by more than the maximum permissible number of outstanding IPDUs (Lk). The value of 'Lk' is defined in "Maximum Number of Outstanding IPDUs - (Lk)" on page M-24.

- Link Send Sequence Number (LNs)

Only IPDUs contain LNs, the send sequence number of transferred PDUs. Prior to transferring an in-sequence IPDU, the value of LNs is set equal to the value of LVs at the originating link station.

- Link Receive State Variable (LVr)

  LVr denotes the sequence number of the next in-sequence IPDU to be received at destination link stations. LVr can take on the values '0' through 'm minus one'. The value of LVr is incremented by one upon receipt of each error free, in-sequence (with an LNs that is equal to the current value of LVr at the receiving link station) IPDU.

- Link Receive Sequence Number (LNr)

  All IPDUs and SPDUs contain LNr, the expected sequence number of the next received IPDU. Prior to transmitting an IPDU or SPDU, LNr is set equal to the current value of LVr at the originating link station. LNr indicates that the link station transferring the LNr has correctly received all IPDUs numbered up to and including 'LNr minus 1'.

M.4.1.3 Functions of the Poll/Final Bit

The poll/final (P/F) bit serves a function in both command LPDUs and response LPDUs. In command LPDUs the 'P/F' bit is referred to as the Poll (P) bit. In response LPDUs it is referred to as the Final (F) bit.

Procedures for use of the 'P/F' bit are described in "Procedure for Use of the P/F Bit" on page M-15.

M.4.2 Link Commands and Responses

Command and response LPDUs transmitted and received by link stations in adjacent nodes are depicted in Figure M-4 on page M-8 and are described in "LLC_Information (LI) Command" through "LLC_Test (LTEST) Command and Response" on page M-11.

M.4.2.1 LLC_Information (LI) Command

LI commands are used to transfer sequentially numbered PDUs that contain information fields, across link connections between link stations in adjacent nodes.

M.4.2.2 LLC_Receive_Ready (LRR) Command and Response

LRR command/response SPDUs are used by link stations to:

- indicate that they are prepared to receive IPDUs
- acknowledge previously received IPDUs numbered up to and including 'LNr minus 1'.

LRR command/response SPDUs may be used to clear busy conditions initiated by the prior transmission of LRNR command or response SPDUs. LRR command SPDUs with 'P = 1' may be used by link stations to solicit the status of the communicating link station in the adjacent node.

PDU	CMD	RSP	Second Octet 8 7 6 5 4 3 2	Bit Positions 1	First Octet 8 7 6	5	4 3	2	1
(I)	LI		LNr	P	LNs				0
(S)	LRR	LRR	LNr	P/F	0 0 0	0	0 0	0	1
Note	LRNR	LRNR	LNr	P/F	0 0 0	0	0 1	0	1
	LREJ	LREJ	LNr	P/F	0 0 0	0	1 0	0	1
(U)		LDM	0 0	F	0 0 0	0	1 1	1	1
Note	LSABME		0 0	P	0 1 1	0	1 1	1	1
	LDISC		0 0	P	0 1 0	0	0 0	1	1
		LUA	0 0	F	0 1 1	0	0 0	1	1
		LPDUR	0 0	F	1 0 0	0	0 1	1	1
	LXID	LXID	0 0	P/F	1 0 1	0	1 1	1	1
	LTEST	LTEST	0 0	P/F	1 1 1	0	0 0	1	1

LDISC = LLC Disconnect
LDM = LLC Disconnected Mode
LPDUR = LLC Protocol Data Unit Reject
LI = LLC Information
LREJ = LLC Reject
LRNR = LLC Receive Not Ready
LRR = LLC Receive Ready
LSABME = LLC Set Asynchronous Balanced Mode – Extended
LUA = LLC Unnumbered Acknowledgment
LXID = LLC Exchange Identification
LTEST = LLC Test

Note: Link stations transmit all Supervisory and Unnumbered command LPDUs with 'P=1'.

Figure M-4. LPDU Commands and Responses

M.4.2.3 LLC_Reject (LREJ) Command and Response

LREJ command/response SPDUs are used by link stations to request retransmission of IPDUs starting with the IPDU numbered LNr. IPDUs numbered 'LNr minus 1' and below are acknowledged. Additional IPDUs pending initial transmission may be transmitted following the retransmitted IPDU(s).

Only one LREJ exception condition for a given direction of information transfer may be established at any time. LREJ exception conditions are cleared (reset) upon receipt of an IPDU with an LNs equal to the LNr contained in the LREJ SPDU.

M.4.2.4 LLC_Receive_Not_Ready (LRNR) Command and Response

LRNR command/response SPDUs are used by link stations to indicate busy conditions; i.e., temporary inability to accept additional IPDUs. IPDUs numbered up to and including 'LNr-1' are acknowledged. IPDU LNr and subsequent IPDUs received, if any, are not acknowledged; the acceptance status of these IPDUs is indicated in subsequent exchanges.

Indication that a busy condition at a link station has cleared is communicated to the communicating link station in the adjacent node by the transmission of an LUA, LRR, LREJ or LSABME.

LRNR command SPDUs with the 'P = 1' may be used by link stations to solicit the status of the communicating link station in adjacent nodes.

M.4.2.5 LLC_Set_Asynchronous_Balanced_Mode_Extended (LSABME) Command

LSABME commands are used to initialize/re-initialize both directions of transmission across the link connection between link stations in adjacent nodes. The DLC.X25.CM initiates transmission of the LSABME command upon receipt of a "CONTACT_ALS" from SNA.PU. No information field is permitted with this command. Link stations in adjacent nodes confirm acceptance of LSABME commands by transferring an LUA response across the link connection at the earliest opportunity. Upon acceptance of an LSABME command, the communicating link station in the adjacent node sets both its send and receive state variables (LVs and LVr) equal to '0' and assumes the link asynchronous balanced mode - extended. When the LUA response is correctly received, the initiating link station also assumes the link asynchronous balanced mode - extended and sets its send and receive state variables (LVs and LVr) equal to '0'. LSABME commands are always transferred with 'P = 1'.

Previously transferred IPDUs that are unacknowledged when the LSABME command is initiated and executed remain unacknowledged (see "Waiting for Acknowledgement" on page M-20). Any transmit buffers that are unacknowledged or pending initial transmission are purged from the link station queue and returned to the upper layer user function.

M.4.2.6 LLC_Disconnect (LDISC) Command

LDISC commands are used by link stations to terminate the operational mode previously set. LDISC informs the communicating link station in the adjacent node that the link station is temporarily suspending operation.

No information field is permitted with LDISC commands. Prior to executing LDISC commands, receiving link stations confirm acceptance by transmitting an LUA response. Transmitting link stations enter the link disconnected phase upon receipt of the acknowledging LUA response. LDISC command LPDUs are always transmitted with 'P = 1'.

Previously transmitted IPDUs that are unacknowledged when the LDISC command is executed remain unacknowledged (see "Waiting for Acknowledgement" on page M-20).

M.4.2.7 LLC_Unnumbered_Acknowledgment (LUA) Response

LUA responses are used by originating link stations to acknowledge receipt and indicate acceptance of LSABME and LDISC commands. Receiving link stations transfer an LUA response before executing the received UPDU command. The LUA response is transferred with 'F = 1' when 'P = 1' in the UPDU command being acknowledged. No information field is permitted with LUA responses.

M.4.2.8 LLC_Disconnected_Mode (LDM) Response

LDM responses are used to report a status where the originating link station is logically disconnected, and is in the LLC disconnected phase. The LDM response may be sent in response to a received LSABME command, to inform the adjacent node link station that the originating link station is still in the LLC disconnected phase and cannot execute the LSABME command. No information field is permitted with the LDM response.

Link stations in the link disconnected phase monitor received commands and:

- react to LSABME and LDISC commands as described in "Link Disconnected Phase" on page M-17; and,
- transfer an LDM response with 'F = 1' to any other UPDU command received with 'P = 1'.

M.4.2.9 LLC_Protocol_Data_Unit_Reject (LPDUR) Response

LPDUR responses are used by link stations to report error conditions that are not recoverable by retransmission of the identical LPDU to the adjacent link station; i.e., one of the following conditions, resulting from the otherwise error free receipt of an LPDU with:

- a LPDU command or response that is invalid or not implemented;
- an information field that exceeds the maximum permissible length;
- an invalid LNr; or,
- an information field which is not permitted or an SPDU or UPDU of incorrect length.

An invalid LNr is one that points to an IPDU that has been previously transmitted and acknowledged or to an IPDU that has not been transmitted and is not the next sequential IPDU pending transmission.

An information field which immediately follows the control field, and consists of 5 octets, is returned with the LPDUR response. This format is shown in Figure M-5 on page M-11.

I-field bits 1 -------- 16	17 --- 23	24	25 --- 31	32	33	34	35	36	37	38	39	40
Rejected LPDU Control Field	LVs	0	LVr	C / R	0	0	0	0	Z	Y	X	W

- Rejected LPDU control field is the control field of the received LPDU that caused the PDU reject condition.
- LVs is the current value of LVs at the link station reporting the rejection condition (bit 23 = low order bit).
- LVr is the current value of LVr at the link station reporting the rejection condition (bit 31 = low order bit).
- 'W=1' indicates that the control field received and returned in bits 1 through 16 was considered invalid or not implemented.
- 'X=1' indicates that the control field received and returned in bits 1 through 16 was considered invalid because the LPDU contained an information field which is not permitted or is an SPDU or UPDU with incorrect length. 'W=1' is required in conjunction with this bit.
- 'Y=1' indicates that the information field received exceeded the maximum established capacity of the link station reporting the condition.
- 'Z=1' indicates that the control field received and returned in bits 1 through 16 contained an invalid LNr.
- C/R - Bit 32 is set to:
  '1' if the rejected LPDU was a response; or,
  '0' if the rejected LPDU was a command.

Figure M-5. LPDUR Information Field Format

M.4.2.10 LLC_Exchange_Identification (LXID) Command and Response

LXID commands are used by ELLC link stations to initiate exchanges of identification information with link stations at adjacent SNA nodes.

M.4.2.11 LLC_Test (LTEST) Command and Response

LTEST commands are used by ELLC link stations to initiate tests of link connections and solicit an LTEST response from ELLC link stations in adjacent nodes.

M.4.3 Exception Condition Reporting and Recovery

Procedures to effect recovery following the detection/occurrence of exception conditions on the connection between link stations in adjacent SNA nodes are described in "Busy Condition" on page M-12 through "LPDU Rejection Condition" on page M-14. Exception conditions described include situations that may occur as the result of underlying network malfunctions or abnormal operational situations.

M.4.3.1 Busy Condition

A busy condition results when an ELLC link station is temporarily unable to continue receiving IPDUs due to internal constraints (e.g., receive buffering limitations). Notification of the busy condition is conveyed to the link station in the adjacent node by transferring an LRNR across the link connection. IPDUs pending transmission may be transmitted by link stations experiencing a busy condition, either prior to, or following, transmission of the LRNR. Recovery from a link station busy condition is indicated to link stations in adjacent nodes as described in "LLC_Receive_Not_Ready (LRNR) Command and Response" on page M-9.

M.4.3.2 LNs Sequence Error

A sequence exception condition results when an error-free (no PDUCS error) IPDU with an LNs that is not equal to the current value of LVr at the receiving link station is received. Receiving link stations do not acknowledge (increment their LVr) IPDUs that result in sequence exception conditions.

The information field of all IPDUs received with an LNs that is not equal to the current value of LVr at the receiving link station is discarded.

ELLC link stations that receive one or more IPDUs having sequence errors but otherwise error-free accept the control information contained in the LNr field and the 'P' bit to perform link control functions (e.g., to receive acknowledgment of previously transmitted IPDUs and to cause the link station to respond ('P = 1')). Therefore, retransmitted IPDUs may contain an LNr field and 'P' bit that are updated, and therefore different from, those contained in the IPDU(s) originally transmitted.

M.4.3.3 LLC REJECT Recovery

LREJ commands and responses are transferred by link stations to initiate exception recovery (retransmission) following detection of sequence errors.

Only one "sent LREJ" exception condition for a link station is established at a time. A "sent LREJ" exception condition is cleared when the requested IPDU is received; or, when a link set-up or disconnection procedure as described in "Link Resetting Procedures" on page M-21 is performed.

Link stations receiving LREJ initiate sequential (re-)transmission of IPDUs starting with the one indicated by the LNr contained in the received LREJ SPDU, if possible (see "Maximum Number of LPDU Transmissions - (LN2)" on page M-24).

M.4.3.4 Time-out Recovery

If, due to a transmission error, a link station does not receive (or receives and discards) a single IPDU or the last IPDU in a sequence of IPDUs, it cannot detect an out-of-sequence exception condition and will, therefore, fail to transmit an LREJ. Link stations shall, following completion of a system specified time-out period (see "LLC_Time-Out_Function - (LFt)" on page M-23) take appropriate recovery action to determine at which IPDU retransmission must begin.

Link stations use the lost reply protection mechanism, described in "Lost Reply Protection" on page M-15, after a system specified time-out period (see "LLC_Time-Out_Function - (LFt)" on page M-23) to determine at which IPDU to begin retransmission.

M.4.3.5 Protocol_Data_Unit_Checking_Sequence (PDUCS)

The purpose of the PDUCS is to detect LPDUs that have been corrupted by the underlying network service.

When an LPDU is to be transmitted the sending link station must generate a PDUCS for the LPDU and store it in the PDUCS parameter in the LPDU header.

- PDUCS (Checksum) Generation Procedure
  - Set up the complete LPDU, including the header and user data (if any). The header must include the PDUCS parameter. The value field of the PDUCS parameter must be set to zero at this point.
  - Initialize two variables (called C^0 and C^1) to zero.
  - For each octet of the LPDU, including the header and the user data (if any), add the octet value to C^0, and then add the value of C^0 to C^1. Octets are processed sequentially, starting with the first octet and proceeding through the LPDU. Addition is performed modulo 256.
  - Calculate the value field of the PDUCS parameter as follows:
    - Let the length of the LPDU, i.e., the number of times the above operation was repeated be 'L';
    - Let the first octet of the PDUCS value, i.e., the nth octet of the LPDU, (where 'n=5'for ELLC architecture), be called 'X';
    - Let the second octet of the PDUCS value, i. e., the (n+1)th octet (where 'n=5' for ELLC architecture), be called 'Y'.

    Then:

    $$X = (((L - i) * C^0) - C^1) \text{ modulo } 256; \text{ and,}$$

    $$Y = (((L - n + 1) * (- C^0)) + C^1) \text{ modulo } 256$$
  - Place the computed values of 'X' and 'Y' in the appropriate octets of the LPDU.

    Note:

    An implementation may use one's complement arithmetic as an alternative to modulo 256 arithmetic. However, if either of the PDUCS octets 'X' and 'Y' has the value minus zero (i.e., x'FF') then it must be converted to plus zero (i.e., x'00') before being stored.
- PDUCS (Checksum) Validation Procedure

  When an LPDU is received it is verified to ensure that it has been received correctly. This is done by computing the PDUCS, using the same algorithm by which it was generated. The nature of the

PDUCS algorithm is such that it is not necessary to compare explicitly the stored PDUCS octets. The procedure described below may be used to verify that an LPDU has been correctly received.

- Initialize two variables (called C^0 and C^1) to zero.
- For each octet in the received LPDU, add the value of the octet to C^0 and then add the value of C^0 to C^1, starting with the first octet and proceeding sequentially through the LPDU. All addition is performed modulo 256.
- When all octets have been sequentially processed, the values of C^0 and C^1 should be zero. If either or both of them is non-zero, the LPDU has been received incorrectly and the verification has failed. Otherwise, the LPDU has been received correctly and the LPDU is processed normally.

Note:

An implementation may use one's complement arithmetic as an alternative to modulo 256 arithmetic. In this case, if either C^0 or C^1 has the value minus zero (i.e., x'FF') it regarded as though it was plus zero (i.e., x'00').

If a PDUCS verification failure occurs, the received LPDU is discarded and no actions is taken by any link station at the receiving DTE as a result of that LPDU.

M.4.3.6 LPDU Rejection Condition

An LPDU rejection condition may be established upon receipt of an error-free LPDU that contains an invalid command/response in the C field, an invalid LPDU format, an invalid LNr or an information field that exceeds the maximum information field length that can be accommodated.

Receiving ELLC link stations report LPDU rejection conditions to the communicating link station in the adjacent node by transferring an LPDUR response across the link connection. ELLC link stations that receive an LPDUR response are responsible for resolving the rejection condition by initiating either a link resetting or link disconnection procedure; or, by causing a clearing or resetting of the underlying virtual circuit. After transmitting an LPDUR response, ELLC link stations maintain the LPDU rejection condition until the link is reset by the communicating link station in the adjacent node. IPDUs received by ELLC link stations in the LPDU rejection condition are discarded, except for the 'P' bit indication (LNr is ignored). The LPDUR response may be repeated at each opportunity until recovery is effected by the communicating link station in the adjacent node, or until internal recovery is initiated locally.

M.4.3.7 Recoverable Packet Layer Error Conditions

Network initiated virtual circuit terminations (clears) and re-synchronizations (resets), as well as interface re-initializations (restarts) are considered to be potentially recoverable at the logical data link control layer. These are indicated by receipt of indication packets con-
+ taining 'Cause Codes' other than the DTE-Generated codes, x'00' and
+ x'80'.

+ M.4.3.8 Effects of LAPB Link Resetting

\+ Resetting of the data link layer re-initializes LAPB sequence numbering
\+ and constitutes an exposure to the integrity of data, for either direction of
\+ transmission. Such exposures may be resolved via logical link stations
\+ using ELLC sequence numbering and verification procedures; and, actual
\+ errors are logged and either:

\+ • recovered by retransmission; or,
\+ • reported to the higher layers of SNA.

M.5 Description of the Procedure

The charts in "Link Station States and Actions" on page M-36 detail the actions, LPDU transfers and state transitions that result from stimuli that can occur at ELLC link stations in the various states of link connections.

M.5.1 Procedure for Addressing

LPDUs are transferred with the address field set to indicate their command/response content.

M.5.2 Procedure for Use of the P/F Bit

Upon receipt of any command LPDU with 'P = 1', ELLC link stations transfer an appropriate response LPDU with 'F = 1' across the link connection at the first respond opportunity (e.g., immediately following the LPDU currently being transmitted, if any). Appropriate responses include:

- an LUA or LDM response to received LSABME and LDISC commands;
- an LPDUR, LREJ, LRNR or LRR response to received IPDU commands; and,
- an LXID or LTEST response to received LXID or LTEST commands, respectively;
- an LPDUR, LRNR or LRR response to received SPDU commands.

The 'P' bit is also used in conjunction with timer recovery conditions as described in "Waiting for Acknowledgement" on page M-20 and may be used as a request for acknowledgment on IPDUs and invitation to transmit, by the upper layer user(s), in application environments that exhibit half-duplex characteristics.

M.6 Lost Reply Protection

ELLC link stations provide a time-out function to protect against dead-lock conditions caused by loss of responses from communicating link stations in the adjacent node due to transmission errors. An LLC Reply Timer, LT1, may be started upon transmission of IPDUs or SPDU commands, or both, during the information transfer phase. LLC Reply Timer, LT1, is also used as described in "Link Set-up" on page M-16 and "Link Disconnection" on page M-16.

If LLC Reply Timer, LT1, expires prior to receipt of an appropriate response from the communicating link station in the adjacent node, ELLC link stations initiate action to recover the link connection. ELLC link stations transfer an appropriate command SPDU and restart LLC Reply Timer, LT1. If LLC Reply Timer, LT1, expires prior to receipt of an appropriate response with 'F = 1' LN2 times, appropriate recovery action is initiated.

M.6.1 Procedures for Link Set-Up and Disconnection

M.6.1.1 Link Set-up

ELLC link stations wishing to set-up the link connection transfer an LSABME command with 'P = 1' and start LLC Reply Timer, LT1 (see "LLC_Time-Out_Function - (LFt)" on page M-23). Upon receipt of an LUA response with 'F = 1' from the link station in the adjacent node, the initiating ELLC link station sets both LVs and LVr equal to '0' and stops LLC Reply Timer, LT1.

Upon receipt of an LSABME command, receiving ELLC link stations prepared to receive IPDUs return an LUA response and set both LVs and LVr equal to '0'. ELLC link stations that, for some reason, are unable or do not desire to enter the information transfer phase, return an LDM response to received LSABME commands.

Upon receipt of an LDM response with 'F = 1' indicating that the adjacent link station cannot accept activation of the link connection, the condition is reported to the upper layer user and no further action is taken by logical link control.

Upon expiration of LLC Reply Timer, LT1, prior to receipt of an appropriate response with 'F = 1', ELLC link stations perform the retransmission procedure described in "LLC_Time-Out_Function - (LFt)" on page M-23 before declaring the link connection to be inoperative and reporting the condition to a higher layer of SNA.

M.6.1.2 Information Transfer Phase

ELLC link stations, having transferred an LUA response to a received LSABME command or having received an LUA response to a transmitted LSABME command, accept and transmit IPDUs and SPDUs in accordance with the procedures described in "Procedures for Information Transfer" on page M-17.

Upon receipt of an LSABME command, an LUA response or an LDM response with 'F = 0', while in the information transfer phase, ELLC link stations conform to the resetting procedure described in "Link Resetting Procedures" on page M-21.

M.6.2 Link Disconnection

During the information transfer phase ELLC link stations, wishing to terminate the link connection, transfer an LDISC command with 'P = 1' across the link connection and start LLC Reply Timer, LT1, (see "LLC_Time-Out_Function - (LFt)" on page M-23).

Upon receipt of a LDISC command, receiving ELLC link stations return an LUA or LDM response and enter the link disconnected phase.

Upon receipt of an LUA or LDM response with 'F = 1' from the communicating link station in the adjacent node, initiating ELLC link stations stop LLC Reply Timer, LT1.

Upon expiration of LLC Reply Timer, LT1, prior to receipt of an appropriate response with 'F = 1', ELLC link stations perform the retransmission procedure described in "LLC_Time-Out_Function - (LFt)" on page M-23 before declaring the link connection to be inoperative and reporting a failure to the higher layers of SNA.

M.6.2.1 Link Disconnected Phase

ELLC link stations, having received an LDISC command and returned an LUA response, or having received an LUA response to a transmitted LDISC command, enter the link disconnected phase.

ELLC link stations, in the link disconnected phase, may initiate link set-up. While in the link disconnected phase, ELLC link stations react to the receipt of LSABME commands as described in "Link Set-up" on page M-16 and transfer an LDM response to received LDISC commands.

Upon receipt of any command (other than LSABME) with 'P = 1', receiving ELLC link stations transfer an LDM response with 'F = 1'.

Other LPDUs are ignored by receiving ELLC link stations while in the link disconnected phase.

M.6.2.2 Collision of UPDU Commands

UPDU command collision situations are resolved in the following manner.

Like Commands: When the sent and received UPDU commands are the same, both ELLC link stations transfer an appropriate UPDU response at the earliest possible opportunity. ELLC link stations place the associated link connection in the indicated state upon receipt of the appropriate UPDU response.

Unlike Commands: When the sent and received UPDU commands, other than LXID and LTEST, are different ELLC link stations place the associated link connection in the LINK_CLOSED state and transfer an LDM response at the earliest possible opportunity. When the sent and received UPDU commands are LXID or LTEST, ELLC link stations transfer the appropriate LTEST and LXID response, respectively, when available.

M.6.3 Procedures for Information Transfer

These procedures apply to the transmission of IPDUs in each direction of transmission during the link information transfer phase.

In the following text, "number one higher" is in reference to a continuously repeated sequence series, i.e., '127' is one higher than '126' and '0' is one higher than '127' for modulo one hundred twenty eight series.

M.6.3.1 Sending IPDUs

ELLC link stations having IPDUs to transfer (i.e., IPDUs not already transferred, or having to be retransmitted as described in "Receiving Reject" on page M-19 or "Waiting for Acknowledgement" on page M-20, transfer them with an LNs equal to the current value of that link stations LVs, and an LNr equal to the current value of the link stations LVr. Upon completion of transmission of each successive IPDU, ELLC link stations increment their LVs by one (1) and start LLC Reply Timer, LT1, if it is not already running.

When the value of LVs, at an ELLC link station, is equal to the last value of LNr received from the communicating link station in the adjacent node plus 'Lk' (where 'Lk' is the maximum permissible number of outstanding IPDUs allowed (see "Maximum Number of Outstanding IPDUs - (Lk)" on page M-24), that ELLC link stations does not transfer any new IPDUs, but may retransmit IPDUs as described in "Receiving Reject" on page M-19 or "Waiting for Acknowledgement" on page M-20.

Note:

To ensure the integrity of information transfer, ELLC link stations do not transfer any IPDUs when the link stations LVs is equal to the last value of LNr received from the link station in the adjacent node plus '127'.

ELLC link stations in the busy condition may continue to transfer IPDUs, provided the communicating link station in the adjacent node is not also in a busy condition. ELLC link stations in the link rejection condition, do not transfer IPDUs.

M.6.3.2 Receiving IPDUs

ELLC link stations not in the busy condition accept the I-field of in-sequence IPDUs (IPDUs with an LNs equal to the current value of the link stations LVr) received with the correct PDUCS, increment the value of the link stations LVr by one and acknowledge receipt of the IPDU(s) by transferring:

- the next sequential IPDU to be transferred, if it is available, or an LRR response SPDU with LNr equal to the current value of its LVr; or,
- an LRR response SPDU response with LNr equal to the current value of its LVr, if no IPDU is available to transfer.

ELLC link stations may ignore the information field contained in IPDUs received while they are in a busy condition.

Note:

ELLC link stations treat IPDUs with zero length information fields the same as any other IPDU at the link station.

M.6.3.3 Receipt of Incorrect LPDUs

ELLC link stations ignore LPDUs received with an incorrect PDUCS and cause a clearing or resetting of the underlying virtual call or permanent virtual circuit, respectively, upon receipt of LPDUs with invalid formats (see "Invalid LPDUs" on page M-5).

ELLC link stations receiving IPDUs with the correct PDUCS, but with an incorrect LNs (i.e., one that is not equal to the current value of LVr at the receiving link station) discard the I-field and transfer an LREJ response with an LNr one higher than the LNs contained in the last correctly received IPDU. Then they discard the I-field, but use the LNr and 'P' bit indications of all IPDUs received with an LNs that is not equal to the current value of LVr at the receiving ELLC link station. Upon receipt of the expected IPDU (i.e., one with an LNs equal to the current value of LVr), receiving ELLC link stations acknowledge the IPDU as described in "Receiving IPDUs" on page M-18.

M.6.3.4 Receiving Acknowledgement

ELLC link stations, even in a busy condition, consider the LNr contained in correctly received IPDUs or SPDUs (LRR, LRNR and LREJ) as acknowledgment for all IPDUs transferred with an LNs up to and including 'LNr minus 1'. ELLC link stations reset LLC Reply Timer, LT1, upon correct receipt of an IPDU or SPDU that actually acknowledges some previously transferred IPDU(s) (i.e., an LPDU with an LNr higher than the value of the last LNr received); or, upon receipt of an SPDU with 'F = 1'.

If LLC Reply Timer, LT1, has been reset with IPDU(s) still unacknowledged, ELLC link stations restart LLC Reply Timer, LT1. If LLC Reply Timer, LT1, expires prior to receipt of an acknowledgment, ELLC link stations follow the retransmission procedure described in "Receiving Reject" and "Waiting for Acknowledgement" on page M-20 with respect to the unacknowledged IPDU(s).

M.6.3.5 Receiving Reject

Upon receipt of an LREJ SPDU, receiving ELLC link stations, supporting LPDU retransmission recovery (see "Maximum Number of LPDU Transmissions - (LN2)" on page M-24), set LVs equal to the LNr contained in the received LREJ, then transfer the corresponding IPDU when it is available or retransmit it; otherwise, they cause a clearing or resetting the the virtual circuit.

ELLC link stations conform to the following with respect to the retransmission of IPDUs:

- An ELLC link station that is transmitting a SPDU or an UPDU when it receives a LREJ, will complete the transmission in progress before commencing transmission of the requested IPDU.
- An ELLC link station that is transmitting an IPDU when an LREJ is received, may abort transmission of the IPDU and commence transmission of the requested IPDU immediately after aborting transmission of the IPDU currently being transmitted.
- An ELLC link station that is not transmitting any LPDU when an LREJ is received, will commence transmission of the requested IPDU immediately.

Other unacknowledged IPDUs already transferred, following the one indicated in the LREJ, are retransmitted following retransmission of the requested IPDU.

If the LREJ was received as a command with 'P = 1', receiving ELLC link stations transfer an LRR or LRNR response with 'F = 1' prior to transmitting or retransmitting the corresponding IPDU.

M.6.3.6 Receiving LRNR

Upon receipt of an LRNR command or response SPDU, ELLC link stations may start Query Timer LTn if it is not running. If Query Timer LTn then expires prior to the receipt of a LUA, LRR, LREJ or LSABME from the communicating link station in the adjacent node, ELLC link stations transmit an appropriate SPDU command with 'P = 1' and may perform the retransmission procedure described under "LLC_Time-Out_Function - (LFt)" on page M-23 before declaring the link connection to be inoperative and reporting the condition to higher layer user(s).

M.6.3.7 Link Station Busy Condition

ELLC link stations experiencing a busy condition transfer an LRNR command or response at a prudent opportunity. While in the busy condition, ELLC link stations accept and process SPDUs and respond LRNR with 'F = 1' to IPDUs and SPDU commands received with 'P = 1'. To clear a busy condition, ELLC link stations transfer either LREJ commands or responses or LRR commands or responses with LNr set to the current value of LVr, depending on whether or not information fields of correctly received IPDUs were discarded.

M.6.3.8 Waiting for Acknowledgement

Originating ELLC link stations maintain an internal retransmission count (Y) which is set equal to '0' upon receipt of an LUA or LRNR, or upon correct receipt of an IPDU or an SPDU with an LNr higher than the last LNr received from the communicating link station in the adjacent node (actually acknowledging some IPDU(s)).

If LLC Reply Timer, LT1, expires, ELLC link stations enter or (re-)enter the timer recovery condition, increment 'Y' by one (1) and set an internal variable (X) to the current value of LVs.

ELLC link stations restart LLC Reply Timer, LT1, set LVs equal to the value of the last LNr received from the communicating link station in the adjacent node and transfer an appropriate SPDU command with 'P = 1'.

Timer recovery conditions are cleared upon receipt of a valid SPDU response with 'F = 1'.

Upon correct receipt of a SPDU response with 'F = 1' and an LNr within the range from the current value of LVs to 'X' included, ELLC link stations reset the timer recovery condition and set LVs equal to the value of LNr in the received SPDU.

Upon correct receipt of an SPDU with 'F = 0' and with an LNr within the range from the current value of LVs to 'X' included, ELLC link stations do not reset the timer recovery condition. The received LNr may be used to update LVs.

When 'Y' is equal to LN2, ELLC link stations initiate a resetting procedure as described in "LLC Rejection Conditions" on page M-22 The value of LN2 is a system parameter (see "Maximum Number of LPDU Transmissions - (LN2)" on page M-24).

M.6.3.9 Link Resetting Procedures

The resetting procedures described here are used, only on link connections perceived by the ELLC link station to be in the information transfer phase, to (re)-initialize both directions of information transfer.

- Local Reset

  ELLC link stations indicate a resetting of the link by transferring an LSABME command LPDU across the link connection. Upon receipt of an LSABME command, ELLC link stations prepared to resume normal operation of the link, transfer an LUA response at the earliest opportunity, and set LVs and LVr equal to '0'. This also clears link station busy conditions, if present. Prior to initiating this link resetting procedure, ELLC link stations may initiate a link disconnection procedure as described in "Remote Reset" below.

- Remote Reset

  Under certain rejection conditions listed in "LLC Rejection Conditions" on page M-22, ELLC link stations may request the adjacent link station to reset the link by transferring an LPDUR response.

  After transmitting an LPDUR response, originating ELLC link stations enter the link rejection condition. The link rejection condition is cleared when the ELLC link station receives an LSABME or an LDISC command or an LDM response from the communicating link station in the adjacent node. Other LPDU commands received while in the link rejection condition cause receiving ELLC link stations to retransmit the LPDUR response with the same information field originally transferred.

  Upon receipt of an LPDUR response, ELLC link stations prepared to resume normal operation of the link transfer an LSABME command LPDU with 'P = 1' across the link connection and start LLC Reply Timer, LT1. Otherwise, ELLC link stations initiate the link disconnection procedure described in "Link Disconnection" on page M-16; or, cause a clearing or resetting of the underlying virtual circuit.

  ELLC link stations may start LLC Reply Timer, LT1, on transferring the LPDUR response. If LLC Reply Timer, LT1, then expires prior to the receipt of an LSABME or a LDISC command from the communicating link station in the adjacent node, ELLC link stations may retransmit the LPDUR response and restart LLC Reply Timer, LT1. Following transmission of the LPDUR response LN2 times ELLC link stations may reset the link as described in "Local Reset" above. The value of LN2 is defined in "Maximum Number of LPDU Transmissions - (LN2)" on page M-24.

M.6.3.10 LLC Rejection Conditions

ELLC link stations may initiate a resetting procedure as described in "Link Resetting Procedures" on page M-21 upon receipt, during the information transfer phase, of an LPDU with the correct PDUCS, and with one of the following conditions:

- the LPDU is unknown as a command or as a response;
- the LPDU does not conform to one of the valid formats;
- the LPDU information field is invalid; or,
- the LPDU contains an invalid LNr as defined in "LLC_Protocol_Data_Unit_Reject (LPDUR) Response" on page M-10.

Coding of the information field of LPDUR responses transferred is given in "LLC_Protocol_Data_Unit_Reject (LPDUR) Response" on page M-10.

Unsolicited LDM - ELLC link stations initiate a resetting procedure as described in "Link Resetting Procedures" on page M-21 upon receipt, during the information transfer phase, of an LDM response or an LPDUR response.

Unsolicited Response - ELLC link stations may initiate a resetting procedure as described in "Link Resetting Procedures" on page M-21 upon receipt, during the information transfer phase an LUA response or an unsolicited LPDU response with 'F = 1'.

M.6.4 Link Connection Procedures

M.6.4.1 Initial Connection Establishment

The ELLC protocols employ the X.25 call set-up procedures described in Chapter 8, "Logical Link Control (LLC) on SNA-to-SNA Connections" on page 8-1 for initial establishment of link connections.

M.6.4.2 Connection Recovery

Procedures are described to allow recovery from certain link connection failures, indicated by PSDNs, to be attempted at the LLC layer when ELLC has been selected. Link failures reported by PSDNS in CLEAR_INDICATION, RESET_INDICATION and RESTART_INDICATION packets with the network generated Cause Codes (other than the DTE-Generated codes x'00' and x'80') are assumed to be temporary in nature and, therefore, potentially recoverable.

- Clears

  ELLC link stations attempt to re-establish virtual calls (switched virtual circuits) cleared by PSDNs via CLEAR_INDICATION packets that carry recoverable Cause Codes (other than the
+ DTE-Generated codes x'00' and x'80') up to LN2 times at intervals
+ of duration LTr before indicating link/station INOP to the higher layers of SNA. Connection recovery is initiated by transferring a CALL_REQUEST packet across the access channel, as depicted in Figure M-6 on page M-26(5), indicating:

  - LLC recovery mode;

- connection recovery request; and,
- connection identification information, if required.

Upon receipt of an INCOMING_CALL packet on a logical channel associated with a link connection perceived to have a connection recovery pending, ELLC link stations cause a clearing of the incoming call by transferring a CLEAR_REQUEST packet with the Cause Code x'00', 'DTE Generated', and the diagnostic code x'5C', 'Logical Channel Reserved'.

- Resets

  ELLC link stations only need to log network initiated resets, of switched or permanent virtual circuits indicated by PSDNs via RESET_INDICATION packets that carry recoverable Cause Codes (other than the DTE-Generated codes, x'00' and x'80',) for future problem determination purposes. Specific recovery action is not required in such instances since ELLC LPDU sequence numbering, acknowledgment and re-transmission procedures provide adequate data integrity mechanisms to cope with temporary failures of this type.

- Restarts

  ELLC link stations treat network initiated restarts, of the X.25 DTE/DCE interface indicated by PSDNs via RESTART_INDICATION packets that carry potentially recoverable Cause Codes (other than the DTE-Generated codes, x'00' and x'80',) as a simultaneous clearing of all virtual calls and a resetting of all permanent virtual circuits at the X.25 DTE/DCE interface.

M.6.5 List of LLC Parameters

The LLC parameters are as follows:

M.6.5.1 LLC_Time-Out_Function - (LFt)

The duration of the LLC time-out function (LFt) is:

$$LFt = (LT1 \bullet LN2 + LTd) \bullet LNd$$

where:

LT1 is a function of the time allowed by link stations between the transmission of commands and receipt of the corresponding acknowledgment.

Upon expiration of timer LT1, Link stations retransmit the unacknowledged command with 'P = 1' and restart timer LT1.

LN2 ≥ '1' is the maximum number of transmissions and retransmissions of a LPDU following the expiration of LLC Reply Timer, LT1.

LTd is typically many times greater than LT1 and is the time to be delayed between consecutive repetitions of LT1•LN2.

LNd ≥ '1' is the maximum number of repetitions of LT1•LN2+LTd to be performed before declaring the logical link connection inoperative.

Although LTd may be defined as zero, experience suggests that when LTd='0' and LNd='1' are used, link connections may often be declared inoperative prematurely, resulting in unnecessary session outages due to momentary network service disruptions.

It is, therefore, essential that LT1, LN2, LTd and LNd have default values that can be overridden by customers as experience indicates.

ELLC link stations start LLC Reply Timer, LT1, upon completion of transmission of IPDUs or SPDU and UPDU commands with 'P = 1'.

M.6.5.2 LRNR Query Time-out - (LTn)

LTn is equivalent to, and may in fact employ the same timer as, LLC Reply Time-out, LT1.

M.6.5.3 LLC Time-Limit - (LT2)

Time-limit LT2 is the maximum time allowed between receipt of a command LPDU from the link station in the adjacent node and transmission of an appropriate response LPDU. This value is product and configuration specific. LT2 must never exceed the time needed to transmit one maximum length frame plus fifty (50) milliseconds.

The duration of Time-limit LT2 is an LLC parameter that is determined by bilateral agreement between communicating link stations.

M.6.5.4 Maximum Number of LPDU Transmissions - (LN2)

The maximum number of transmissions and retransmissions of a given LPDU following the expiration of LLC Reply Timer, LT1, is a LLC parameter (LN2) whose value is determined by bilateral agreement between adjacent link stations.

Note:

To facilitate throughput enhancement in environments where the quality of service exhibited by underlying network services afford adequate data integrity support of the retransmission recovery function may be bypassed when the value of LN2 is equal to one (1).

M.6.5.5 Maximum Number of Bytes in an IPDU - (LN1)

The maximum permissible number of octets (bytes) in an IPDU is an LLC parameter (LN1) which depends upon the maximum length of the information fields transferred across the link connection.

M.6.5.6 Maximum Number of Outstanding IPDUs - (Lk)

The maximum permissible number (Lk) of sequentially numbered IPDUs that link stations may have outstanding (i.e., unacknowledged) at any given time is an LLC parameter which can never exceed one hundred twenty-seven (127). The value of 'Lk' is determined by bilateral agreement between adjacent link stations. It is recommended that 'Lk' be a parameter whose default value can be overridden.

M.6.5.7 Link Idle Timer - (LTi)

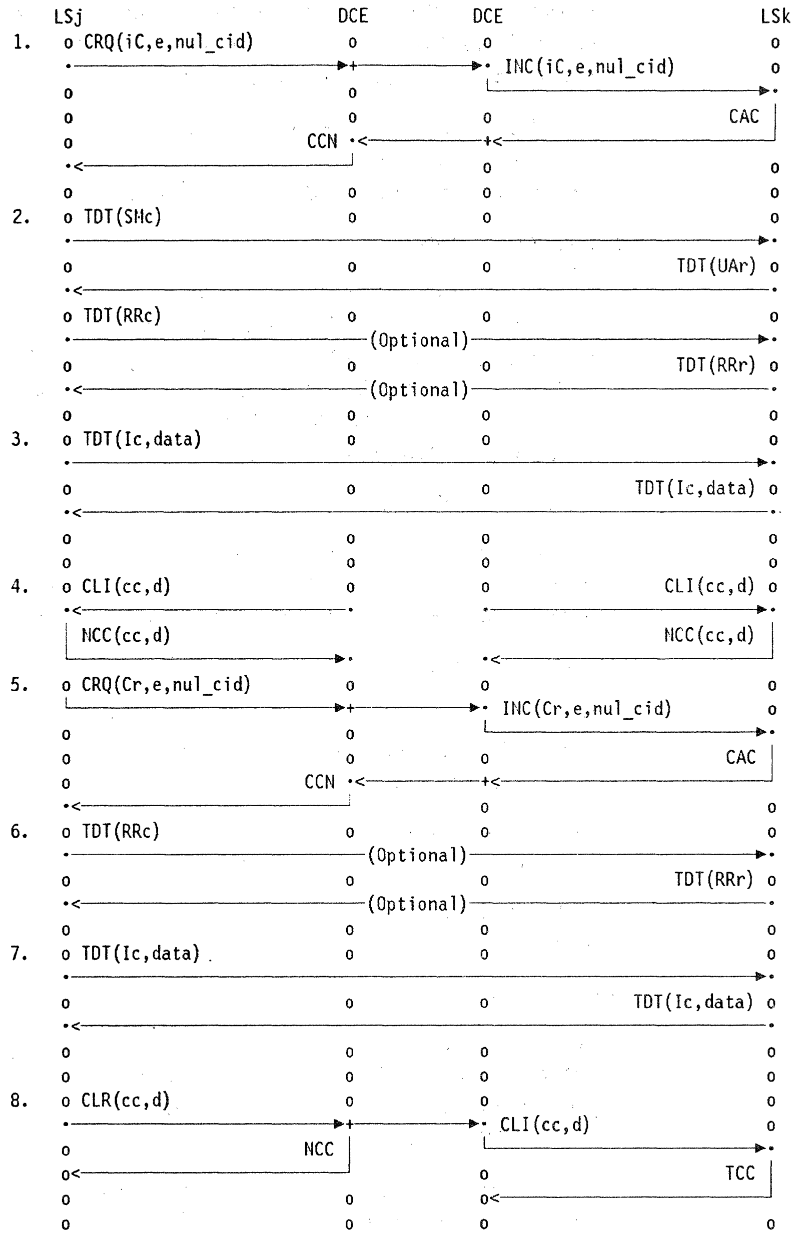
The period of time that a link station may allow the link connection to remain in the idle state (see "Link Channel States" on page M-5) before, initiating a procedure to protect against half-open link connections by,
+ transmitting an LRR command LPDU. LTi is many times greater than LT1.

+ M.6.5.8 Retry Interval Timer (LTr)

+ The period of time that a link station waits, after receipt of lower layer
+ service interruption signals, before attempting to re-establish the effected
+ connection. The duration of Retry Interval Timer LTr should be randomly
+ variable from 'n' to ('n' + 60) seconds.

M.7 LPDU Flow Examples

Sample ELLC LPDU flows depicting initial link establishment, initialization, information exchange, recoverable call clearing and connection recovery are shown in Figure M-6 on page M-26.



Legend:

cc:	Clearing Cause code
cid:	Connection Identifier
Cr:	Connection Recovery Indication
d:	Diagnostic code
e:	ELLC protocol identifier
Ic:	Information command
iC:	Initial Connection indication
LS(i):	Link Station 'i'
nul:	Null
SM:	SABME Unnumbered command
UA:	Unnumbered Acknowledgement response

Figure M-6. ELLC Protocol_Data_Unit Flows

The following notes are keyed to Figure M-6.

1. Initial Connection Initiation

Link connection establishment is initiated by the transfer of a CALL_REQUEST packet, to the network access DCE, with the following parameters in the CUD field:

- (iC) - Initial connection indicator
- (e) - Extended LLC protocol indicator
- (cid) - Connection identifier (optional)

2. Link Initialization

   Link initialization is initiated by the transfer of a DTE_DATA packet containing an LSABME command LPDU in the user data field and may be terminated either by the receipt of an LUA command LPDU or receipt of an LUA command LPDU followed by an exchange of DTE_DATA packets containing LRR command and response LPDUs, respectively.

3. Information Exchange

   Information is exchanged between adjacent link stations by the transfer of DATA packets or packet sequences with the user data field containing an information command LPDU.

4. Network Initiated Call Clearing

   Network initiated call clearing is signalled by the transfer of unsolicited CLEAR_INDICATION packets to both the calling and called link stations containing:

   - (cc) - Cause Codes in the Clearing Cause field.
   - (d) - Diagnostic Code in the Diagnostic Code field.

+ + Retry Interval Timer LTr duration between Network Call Clearing and Connection Recovery.

5. Connection Recovery

   Link connection recovery, following a recoverable network initiated call clearing is initiated by the transfer of a CALL_REQUEST packet, to the network access node, with the following parameters in the CUD field:

   - (Cr) - Connection Recovery indication
   - (e) - Enhanced LLC protocol indicator
   - (cid) - Connection identifier (optional)

6. Link Initialization/Assurance

   Link re-initialization is accomplished by an exchange of LRR command and response LPDUs, respectively.

7. Continue Information Exchange

   Proceeds as in item 3. above.

8. Connection Termination

   Termination of a link connection is initiated by the transfer of a CLEAR_REQUEST packet, to the network access node, containing the following parameters:

   - (cc) - Clearing Cause Code; and,
   - (d) - Diagnostic Code.

M.8 LINK STATION FINITE STATE MACHINES

M.8.1 Chart Description

Operation of the ELLC protocol for link stations is formalized by the charts contained in "Link Station States and Actions" on page M-36 for the link connection states defined in "ELLC STATE DESCRIPTIONS" on page M-29. Action(s) taken by link station(s) as a result of particular stimuli are shown at the intersection of the various link connection states and the stimulus. ELLC link connection states include the predicate conditions defined in "PREDICATES" on page M-30 and the state variables defined in "State Variables" on page M-31, either or both of which are indicated under the heading(s) 'P: V:' (when appropriate) in the charts in "Link Station States and Actions" on page M-36. ELLC stimuli include the events as well as the command and response LPDUs defined in "ELLC Stimuli" on page M-32.

Information contained at these intersections specify the action(s) taken (denoted by two uppercase letters 'LL'), the basic procedure executed (denoted by the small letters 'bp' concatenated with an upper case letter 'L'), the PDU(s) transferred (if any), signified by the protocol data unit identifier enclosed in brackets with any required parameters [PDU_id(p1,..,pn)] and the new state of the link connection to be entered (if any).

The PDU transferred, [PDU], may be any of the LLC command or response LPDUs listed in "Commands Sent and Received" on page M-32 and "Responses Sent and Received" on page M-33 and a small letter 'c' or 'r' may be appended signifying command or response, respectively; or the LPDU indicated by the PDU output scheduling algorithm signified by an undefined protocol machine [PDU_Out_UPM]. XPo, TPo and LPo signify the output PDU indicated by execution of the basic procedures X, T and L, respectively. Additional appendages that specify the value of the P-bit for command LPDUs and the F-bit for response LPDUs when necessary, include:

- ^{0} - signifying a P/F-bit value of '0';
- ^{1} - signifying a P/F-bit value of '1';
- ″ - signifying a P/F-bit value equal to the value of the variable, Vf; and
- ′ - signifying an F-bit value equal to the value of the P-bit in the received command LPDU to which it responds.

In the event the PDU transferred causes a packet layer clearing or resetting of the underlying virtual circuit, an appropriate diagnostic code is included (see Appendix H, "DTE-Generated Diagnostic Codes" on page H-1 for DTE Generated Diagnostic codes used when the virtual circuit for SNA-to-SNA connections are cleared or reset; or the DTE/DCE interface is restarted). When no [PDU] is indicated, nothing is transferred across the link connection to the link station in the adjacent node as the result of that particular stimulus.

Applicable ELLC link connection state transitions are specified under the heading 'New State' when the link connection is to be placed in a different state following the specified action(s) and/or PDU transfer(s). Link connections remain in the current state when no new state to be entered is specified at a particular intersection.

Alternative procedures, denoted by lower case letters 'l' or the word 'or' under the 'ALT' heading, are specified where appropriate.

References to clarifying notes (denoted by '#n' (where 'n' is a decimal integer) under the 'ALT' heading) are also provided at certain intersections, where deemed prudent, to denote extenuating circumstances considered essential to proper operation of the protocol, including:

- When an exchange of link station identification information is not required prior to link set-up.
- The virtual call (switched virtual circuit) supporting the link connection is cleared (e.g., CLEAR_REQUEST or CLEAR_INDICATION) the underlying virtual circuit is terminated and the link connection placed in the INOPERATIVE state.

The sample sequences shown in Figure M-6 on page M-26 represent one example of how the tables may be used.

M.8.1.1 ELLC STATE DESCRIPTIONS

INOPERATIVE: The link station, not having resources allocated sufficient to support link connection, is non-functional and reacts positively only to link activation stimulus as specified in "INOPERATIVE State" on page M-36

LINK_CLOSED: The link station, having sufficient resources to support link connection allocated, reacts to stimuli as specified in "LINK_CLOSED State" on page M-37 when authorized and prepared to support link initialization.

LINK_OPENING: Link stations having initiated the link set-up procedure, by transferring an SABME command LPDU across the link connection, react to stimuli as specified in "LINK_OPENING State" on page M-39 pending receipt of link set-up confirmation (UA response LPDU) from the link station in the adjacent node.

LINK_CLOSING: Link stations having initiated the link disconnection procedure, by transferring a DISC command LPDU across the link connection, react to stimuli as specified in " LINK_CLOSING State" on page M-41.

LINK_OPENED: Link stations having completed the link set-up procedure react to stimuli as specified in "LINK_OPENED State" on page M-42 in the absence of error or exception condition(s) effecting the associated link connection.

CHECKPOINTING: Link stations having transferred an S-format command LPDU with 'P=1' across the link connection as a result of the expiration of LLC Reply Timer LT1, on the associated link connection react to stimuli as specified in "CHECKPOINTING State" on page M-46.

LINK_RESETING: Link stations having received an SABME command LPDU from the link station in the adjacent node, initiating the link resetting procedure, react to stimuli as specified in "LINK_RESETING State" on page M-53 until the resetting procedure is completed by the transfer of either a UA or DM response LPDU as directed by a higher layer function.

LINK_RECOVERY: Link stations having received a FRMR response LPDU from, or transferred a FRMR response LPDU to, the link station in the adjacent node react to stimuli as specified in "LINK_RECOVERY State" on page M-55 until a resetting procedure is completed for the link connection.

M.8.1.2 PREDICATES

ELLC predicate conditions include:

P:

which signifies general condition(s) for the link connection and may take on the values:

- 'Nul' - signifying that no outstanding exceptional general conditions exists for the link connection.
- 'RJN' - signifying that an out-of-sequence IPDU has resulted in the transfer of an REJ command or response LPDU to the link station in the adjacent node.

Pb_Busy:

Signifies condition(s) for the link relative to resource constraints that temporarily prevent acceptance of I-format LPDU(s):

- 'B' by both the local link station and its communicating partner in the adjacent node;
- 'L' by the local link station;
- 'N' by neither the local nor its communicating partner in the adjacent node; or,
- 'R' by the link station in the adjacent node.

Pc_Pending Command

Identifies the pending command LPDU when a command transmission is awaiting completion of a checkpointing cycle, and may take on the values:

- 'D' signifying a Disconnect command;
- 'R' signifying a Receive_Ready command;
- 'T' signifying a Test command;
- 'X' signifying an Exchange_Identification; or
- 'N' signifying that no command LPDU is pending.

Pr_Recovery.Status

- 'Nul' signifying no recovery procedure in process;
- 'L' signifying recovery due to a locally detected PDU_Rejection condition in process; or,

- 'R' signifying recovery due to a remotely detected PDU_Rejection condition in process.

Pt_TEST.Status

- 'Nul' signifying that no TEST of the link connection is in process;
- 'I' signifying that an incoming TEST response LPDU from the link station in the adjacent node is pending;
- 'O' signifying that an outgoing TEST response LPDU to the link station in the adjacent node is pending;
- 'IO' signifying that an incoming TEST response LPDU from and an outgoing TEST response LPDU to the link station in the adjacent node are both pending.

Px_XID.Status

- 'Nul' signifying that no exchange of identification information (XID) is in process;
- 'I' signifying that an incoming XID response LPDU from the link station in the adjacent node is pending;
- 'O' signifying that an outgoing XID response LPDU to the link station in the adjacent node is pending;
- 'IO' signifying that an incoming XID response LPDU from and an outgoing XID response LPDU to the link station in the adjacent node are both pending.

M.8.1.3 State Variables

ELLC state variables include:

Va - Acknowledged LPDU: containing the last Nr value received, or '0' immediately following completion of the link set-up procedure;

Vf - Final Bit Value: containing the value for a final bit pending transmission (e.g., associated P-bit value received).

Vi - Initialization Status:

Signifies link initialization progress and may take on the values:

- 'L' signifying locally initiated link set-up;
- 'R' signifying remotely initiated link set-up;
- 'B' signifying locally and remotely initiated link set-up;
- 'P' signifying initialization confirmation pending; or,
- 'Nul' signifying initialization completed/not started.

Vr - Next IPDU In: denoting the sequence number (Ns) of the next in-sequence I-format LPDU to be received across the link connection from the link station in the adjacent node.

Vs - Next IPDU Out: denoting the sequence number (Ns) of the next in-sequence I-format LPDU to be transferred across the link connection to the link station in the adjacent node.

M.8.1.4 ELLC Stimuli

ELLC protocol stimuli include the events, commands and responses described in the following paragraphs.

Events

- L3RDY - PACKET_LAYER (Layer 3) READY: representing a signal from the X.25 Packet Layer (layer 3) that the underlying virtual circuit, in the READY (p4 or d1) state, is prepared to support a link connection.
- LSTRT - LINK_START: representing a higher layer stimulus to establish a link connection to a communicating link station in the adjacent node.
- LSTOP - LINK_STOP: representing a higher layer stimulus to terminate the link connection to the communicating link station in the adjacent node.
- L3NOP - LAYER_3_INOPERATIVE: representing a signal from the X.25 Packet Layer (layer 3) that the underlying virtual circuit, in the INOPERATIVE state, is no longer capable of supporting a link connection.
- ELBSY - ENTER_LOCAL_BUSY: representing a signal from the DLC.X25_Manager informing the link station of a local resource constraint that temporarily prohibits the continued acceptance of I-format LPDUs.
- XLBSY - EXIT_LOCAL_BUSY: representing a signal from the DLC.X25_Manager informing the link station of the removal of an existing local resource constraint.
- ELPDU - ERRONEOUS_LLC_PROTOCOL_DATA_UNIT: representing receipt of an erroneous LPDU (e.g., one containing an unidentifiable LLC command or response, I field too long, etc.) on the link connection.
- XCHID - EXHCANGE_IDENTIFICATION: representing a higher layer request/authorization to transfer LLC link station identification information.
- LTEST - LINK_TEST: representing a higher layer request/authorization to transfer LLC link test data.
- SDATA - SEND_DATA: representing a higher layer request for the transfer of user data to the link station in the adjacent node.
- ELT1X - ELLC_LINK_REPLY_TIMEOUT_EXPIRATION: representing expiration of the LLC link reply timeout, Timer LT1.
- ELTiX - ELLC_LINK_IDLE_TIMEOUT_EXPIRATION: representing expiration of LLC link query timeout, Timer LTi.

Commands Sent and Received

- LI - I-format LPDU: representing a DATA packet or packet sequence containing an I-format LPDU in the user data field(s).

- LSM - LLC_SET_MODE (LSABME): representing a DATA packet containing a Set_Mode command LPDU (LSM) in the user data field.
- LDC - LLC_DISCONNECT (LDISC): representing a DATA packet containing a Disconnect command LPDU (LDC) in the user data field.
- LXC - LLC_EXCHANGE_IDENTIFICATION: representing a DATA packet or packet sequence containing an Exchange_Identification command LPDU (LXC) in the user data field(s).
- LTC - LLC_LOGICAL_LINK_TEST: representing a DATA packet or packet sequence containing a Link_Test command LPDU (LTC) in the user data field(s).
- LRR - LLC_RECEIVE_READY: representing a DATA packet containing a Receive_Ready command LPDU (LRR) in the user data field.

Responses Sent and Received

- LDM - LLC_DISCONNECTED_MODE: representing a DATA packet containing a Disconnected_Mode response LPDU (LDM) in the user data field.
- LPR - LLC_PDU_REJECT: representing a DATA packet containing a PDU_Reject response LPDU (LPR) in the user data field.
- LUA - LLC_UNNUMBERED_ACKNOWLEDGE: representing a DATA packet containing an Unnumbered_Acknowledge response LPDU (LUA) in the user data field.
- LXR - LLC_EXCHANGE_IDENTIFICATION: representing a DATA packet or packet sequence containing an Exchange_Identification response LPDU (LXID), including link station identification information, in the user data field(s).
- LTR - LLC_TEST: representing a DATA packet or packet sequence containing a Link_Test response LPDU (LTR), including test data, in the user data field(s).
- LRR - RECEIVE_READY: representing a DATA packet containing a Receive_Ready response LPDU (LRR) in the user data field.

M.8.1.5 BASIC PROCEDURES

Basic procedures defined for ELLC link stations, specified at the intersection of a state/condition/option and a stimulus, denoted by a small letter 'bp' concatenated with a capital letter 'L' (bpL), include:

bpA - Acknowledgment

Process the received Nr value according to the procedure specified by CHART_A in "Acknowledgment" on page M-57 and if Va<Nr<Vs : Va=Nr, RT1; Va<Nr=Vs : Va=Nr, TT1, ITi; ELSE ; NS.

bpL - Limit

Perform the procedure specified by CHART_L in "Limit" on page M-57 which increments the (re)-transmission count 'Ct' by one, then if Ct=N2 : report the failing procedure to, and await further direction from, a higher layer of SNA; Else : retry the indicated protocol procedure.

bpR - Rejection

Process the received REJECT command/response LPDU according to the procedure specified by CHART_R in "Rejection" on page M-57 and if Va<Nr<Vs : Va=Vs=Nr, RT1; Va<Nr=Vs : Va=Vs=Nr, TT1, ITi; ELSE : Vs=Nr.

bpT - TEST

Perform the procedure specified by CHART_T in "Link Test" on
+ page M-57 with the result that if Pt=Nul : Pt=Ip, TTi, RT1, Ct='0',
+ [LTC[1]]; Pt=Rp : IH, Pt=Nul, [LTR(F=Vf,id)]; Pt=IRp : IH, Pt=Ip, [LTR(F=Vf,id)]; Else : LE.

bpX - EXCHANGE_IDENTIFICATION

Perform the procedure specified by CHART_X in "Exchange
+ Identification" on page M-58 with the result that if Px=Nul : Px=Ip,
+ TTi, RT1, Ct='0', [LXC[1]]; Px=Rp : IH, Px=Nul, [LXR(F=Vf,id)]; Px=IRp : IH, Px=Ip, [LXR(F =Vf,id)]; Else : LE.

M.8.1.6 Actions

Actions taken by ELLC link stations, denoted at the intersection of a state/condition/option and a stimulus, are identified by two capital letters 'LL' which are defined as follows:

DB - Discard BTU

Discard the contents of the information field of the received PDU and take no further action as a result of its receipt.

DL - Disable Link

Destroy the link connection, releasing the Access Channel and Media Access Port associated with the link appearance.

EL - Enable Link

Establish a link connection by associating a specific Access Channel and Media Access Port as required to create a link appearance.

FB - Forward BTU

Forward the received Basic Transmission Unit to the higher layer using protocol entity.

IH - Inform Higher Layers

Inform a higher layer of SNA of the occurrence via internal signalling mechanisms.

IP - Ignore Protocol Data Unit

Take no action and ignore the received protocol data unit in its entirety.

ITi - Initiate Query Timer, LTi

Initiate a logical link timeout for the duration of Query Timer, LTi.

LE - Local Procedure Error

Representing an internal signalling error or illogical protocol sequence on the part of the ELLC link station that may be either ignored or reported to a higher layer of SNA for analysis.

NA - Not Applicable

Identifies events/actions/responses that cannot occur for a given state/condition/alternative.

NS - No Specific Action

No specific action is required by the ELLC link station protocol.

QL - Queue LPDU

Place the output BTU in the information field of an Information LPDU, place the LPDU on the outbound queue for the associated logical link, and pass control to the PDU_Out_UPM.

RE - Remote Procedure Error

Representing a protocol procedure error on the part of the ELLC link station in the adjacent node that may be either ignored or reported to a higher layer of SNA for future analysis.

RS - Report Status

Report the current status of the ELLC link station to a higher layer of SNA.

SL - Set-Up Link

Initiate the link set-up procedure described in § 4.5.4.1.

TC - Terminate Contact

Terminate the SNA_CONTACT phase and signal CONTACTED to a higher layer of SNA.

TL - Terminate Link

Terminate the link initialization procedure and transfer an unsolicited DISCONNECTED_MODE response to inform the link station in the adjacent node.

TTi - Terminate Timer LTi

Stop the link idle time-out, LTi.

M.8.2 Link Station States and Actions

M.8.2.1 INOPERATIVE State

CHART 1-E: EVENTS in INOPERATIVE State		
Stimuli P: V: ALT	Action(s) [PDU Transfers]	**New State**
L3RDY	EL, P=Nul	LINK_CLOSED
LSTRT	LE	
LSTOP	LE	
L3NOP	LE	
ELBSY	LE	
XLBSY	LE	
XCHID	LE	
LTEST	LE	
SDATA	LE	
ELPDU	IP	
ELT1X	LE	
ELTiX	LE	

CHART 1-I: I-Format LPDUs in INOPERATIVE State		
Stimuli P: V: ALT	Action(s) [PDU Transfers]	**New State**
LI	IP	

CHART 1-S: S-format LPDUs in INOPERATIVE State		
Stimuli P: V: ALT	Action(s) [PDU Transfers]	**New State**
LRR	IP	
LNR	IP	
LRJ	IP	

CHART 1-U: U-format LPDUs in INOPERATIVE State		
Stimuli P: V: ALT	Action(s) [PDU Transfers]	**New State**
LSM|LUA	IP	
LDC|LDM	IP	
LXC|LXR	IP	
LTC|LTR	IP	
LPR	IP	

M.8.2.2 LINK_CLOSED State

CHART 2-E: EVENTS in LINK_CLOSED State			
Stimuli P: V: ALT		**Action(s) [PDU Transfers]**	**New State**
L3RDY		LE	
LSTRT	c+t+xNul+ iNul	SL, Vi=L, Ct=0, TTi, RT1 [LSM^{1}]	LINK_OPENING
	iR	SL, Vi=P, TT1, ITi [LUA"]	LINK_OPENING
	ELSE	LE	
LSTOP		TL, Vi=Nul, TT1, ITi [LDM^{0}]	
L3NOP		DL	INOPERATIVE
ELBSY	bR	Pb=B	
	ELSE	Pb=L	
XLBSY		LE	
XCHID		bpX [XPo']	
LTEST		bpT [TPo']	
SDATA		LE	
ELPDU		RE	
ELT1X	Ct<LN2+ xI|IO	bpL [LXC^{1}(id)]	
	tI|IO	bpL [LTC^{1}(data)]	
	ELSE	LE	
ELTiX	Nul	LE	

CHART 2-I: I-Format LPDUs in LINK_CLOSED State		
Stimuli P: V: ALT	**Action(s) [PDU Transfers]**	**New State**
LIc^{0}	IP	
LIc^{1}	NS [LDM^{1}]	
LIr$^{0\|1}$	IP	

CHART 2-S: S-format LPDUs in LINK_CLOSED State		
Stimuli P: V: ALT	**Action(s) [PDU Transfers]**	**New State**
LRR|LNR|LRJc^{0}	IP	
LRR|LNR|LRJc^{1}	NS [LDM^{1}]	
LRR|LNR|LRJr$^{0\|1}$	IP	

CHART 2-U: U-format LPDUs in Received LINK_CLOSED State		
Stimuli P: V: ALT	Action(s) [PDU Transfers]	New State
LSM Nul+iNul|R	IH, Vi=R, Vf=P, ITi	LINK_OPENING
iP	IH, Pc=Pt=Px=Va=Vf=Vs=0, ITi [LUA"]	
ELSE	LE	
LDC	DL [LDM']	
LUA	IP	
LDM	IP	
LPR	IP_(RE)	

CHART 2-U: U-format LPDUs in LINK_CLOSED State (Continued)		
Stimuli P: V: ALT	Action(s) [PDU Transfers]	New State
LXC	IH, Px=0, Vf=P	
LXR°|¹ xI	IH, Px=Nul, TT1	
xIO	IH, Px=0, TT1	
ELSE	IP_(RE)	
LTC	IH, Pt=0, Vf=P	
LTR°|¹ tI	IH, Pt=Nul, TT1	
tIO	IH, Pt=0, TT1	
ELSE	IP_(RE)	

M.8.2.3 LINK_OPENING State

CHART 3-E: EVENTS in LINK_OPENING State

Stimuli	P: V: ALT	Action(s)	[PDU Transfers]	New State
L3RDY		LE		
LSTRT		LE		
LSTOP		Vi=Nul, TT1, ITi	[LDM^{0}]	LINK_CLOSED
L3NOP		DL		INOPERATIVE
ELBSY	bR	Pb=B		
	ELSE	Pb=L		
XLBSY	bB	Pb=R		
	ELSE	Pb=Nul		
XCHID		LE		
LTEST		LE		
SDATA		LE		
ELPDU		IP		

CHART 3-E: EVENTS in LINK_OPENING State (Continued)

Stimuli	P: V: ALT	Action(s)	[PDU Transfers]	New State
ELT1X		bpL	[LPo']	
ELTiX		LE		

CHART 3-I: I-Format LPDUs in LINK_OPENING State

Stimuli	P: V: ALT	Action(s)	[PDU Transfers]	New State
LIic|r^{0}	iP	IH, Vi=Nul, FB, RTi	[LRRr^{0}]	LINK_OPENED
	ELSE	IP		
LIic^{1}	iP	IH, Vi=Nul, FB, RTi	[LRRr^{1}]	LINK_OPENED
	ELSE	IP		
LIir^{1}		IP		

CHART 3-S: S-format LPDUs in LINK_OPENING State			
Stimuli P: V: ALT	Action(s)	[PDU Transfers]	New State
LRR¦LNR¦LRJc^{0}	IP		
LRR(0)¦ LRJ(0)c^{1} iP	IH, Pb=Nul, Vi=Nul, RTi	[LRRr^{1}]	LINK_OPENED
ELSE	IP		
LNR(0)c^{1}	IH, Pb=R, Vi=Nul, RTi	[LRRr^{1}]	LINK_OPENED
ELSE	IP		
LRR¦LNR¦LRJr^{0,1}	IP		

CHART 3-U: U-format LPDUs in LINK_OPENING State			
Stimuli P: V: ALT	Action(s)	[PDU Transfers]	New State
LSM	Vi=R, TT1, ITi	[LUA']	
LDC	IH, Vi=Nul, TT1, ITi	[LDM']	LINK_CLOSED
LUA^{1}	IH, Pc=Pt=Px=Va=Vf=Vi=Vr=Vs=Nul, TTi, RTi	[LRRc^{1}]	CHECKPOINTING
LDM^{1}	IH, Vi=Nul, TT1, ITi		LINK_CLOSED
LDM¦LUA^{0}	IP		
LXC	IP		
LTC	IP		
LPR	IP_(RE)		
LTR	IP_(RE)		
LXR	IP_(RE)		

M.8.2.4 LINK_CLOSING State

CHART 4-E: EVENTS in LINK_CLOSING State		
Stimuli P: V: ALT	Action(s) [PDU Transfers]	New State
L3RDY	LE	LINK_CLOSED
LSTRT	LE	
LSTOP	LE	
L3NOP	RS	INOPERATIVE
ELBSY	Pb=L	
XLBSY	LE	
XCHID	LE	
LTEST	LE	
SDATA	LE	
ELPDU	IP	
ELT1X	bpL	
ELTiX	LE	

CHART 4-I: I-Format LPDUs in LINK_CLOSING State		
Stimuli P: V: ALT	Action(s) [PDU Transfers]	New State
LI	IP	

CHART 4-S: S-format LPDUs in LINK_CLOSING State		
Stimuli P: V: ALT	Action(s) [PDU Transfers]	New State
LRR|LNR|LRJ	IP	

CHART 4-U: U-format LPDUs in LINK_CLOSING State		
Stimuli P: V: ALT	Action(s) [PDU Transfers]	New State
LSM	IH, TT1, ITi [LDM']	LINK_CLOSED
LDC	IH, TT1, ITi [LUA']	LINK_CLOSED
LUA^1|LDM	IH, TT1, ITi	LINK_CLOSED
LUA^0	IP	
LXC	IP	
LTC	IP	
LPR	IP_(RE)	
LTR	IP_(RE)	
LXR	IP_(RE)	

M.8.2.5 LINK_OPENED State

CHART 5-E: EVENTS in LINK_OPENED State				
Stimuli	P: V: ALT	Action(s)	[PDU Transfers]	New State
L3RDY		LE		
LSTRT		LE		
LSTOP		TTi, RT1, Ct=0	[LDC^1]	LINK_CLOSING
L3NOP		LE		
ELBSY	bL|B	LE		
	RJN+|bR	Pb=B		
	ELSE	Pb=L		
XLBSY	bL	Pb=Nul, RT1, Ct=0	[LRRc^1]	CHECKPOINTING
	bB	Pb=R, RT1, Ct=0	[LRRc^1]	CHECKPOINTING
	RJN+bL	Pb=Nul, TTi, IT1, Ct=0	[LRRc^1]	CHECKPOINTING
	RJN+bB	Pb=R, TTi, RT1, Ct=0	[LRRc^1]	CHECKPOINTING
	ELSE	LE		
XCHID	xNul	Px=I, TTi, RT1, Ct=0	[LXC^1]	CHECKPOINTING
	x0	IH, Px=Nul	[LXR"]	
	xI0	IH, Px=I	[LXR"]	
	ELSE	LE		
LTEST	tNul	Pt=I, TTi, RT1, Ct=0	[LTC^1]	CHECKPOINTING
	t/o	IH, Pt=Nul	[LTR"]	
	tI0	IH, Pt=I	[LTR"]	
	ELSE	LE		
SDATA		QL	[PDU_Out_UPM]	
ELPDU		IH_(RE), TT1, ITi, Pr=L	[LPR^0]	LINK_RECOVERY
ELT1X	RJN+|bR	RT1, Ct=0	[LRRc^1]	CHECKPOINTING
	RJN+bL|B	RT1, Ct=0	[LNRc^1]	CHECKPOINTING
	bL|B	IT1, Ct=0	[LNRc^1]	CHECKPOINTING
	ELSE	IT1, Ct=0	[LRRc^1]	CHECKPOINTING
ELTiX		LE		

CHART 5-I: I-Format LDPUs in LINK_OPENED State				
Stimuli	P: V: ALT	Action(s)	[PDU Transfers]	New State
LIic|r^0	RJN	bpA, FB, P=Nul	[PDU_Out_UPM]	
	bL|B	bpA, DB	[LNRr^0]	
	bR	bpA, DB	[LRRr^0]	
	RJN+bL|B	bpA, DB, P=Nul	[LNRr^0]	
	RJN+bR	bpA, FB, P=Nul	[LRRr^0]	
	ELSE	bpA, FB	[PDU_Out_UPM]	
LIic^1	RJN	bpA, FB, P=Nul	[LRRr^1]	
	bL|B	bpA, DB	[LNRr^1]	
	RJN+bL|B	bpA, DB, P=Nul	[LNRr^1]	
	RJN+bR	bpA, FB, P=Nul	[LRRr^1]	
	ELSE	bpA, FB	[LRRr^1]	
LIir^1	ELSE	IH_(RE), Va=Vs=Nr, TT1, ITi, Pr=L	[LPR^0]	LINK_RECOVERY
LIec|r^0	RJN,bL|B	bpA, DB	[LNRr^0]	
	RJN+bL|B	bpA, DB	[LNRr^0]	
	bR	bpA, DB, P=RJN	[LRJr^0]	
	RJN+bR	bpA, DB		
	ELSE	bpA, DB, P=RJN	[LRJr^0]	
LIec^1	RJN,bL|B	bpA, DB	[LNRr^1]	
	RJN+bL|B	bpA, DB	[LNRr^1]	
	bR	bpA, DB, P=RJN	[LRJr^1]	
	RJN+bR	bpA, DB	[LRRr^1]	
	ELSE	bpA, DB, P=RJN	[LRJr^1]	
LIer^1	ELSE	IH_(RE), Va=Vs=Nr, TT1, ITi, Pr=L	[LPR^0]	LINK_RECOVERY

CHART 5-S: S-format LPDUs in LINK_OPENED State (Continued)

<table>
<tr><th>Stimuli</th><th>P: V: ALT</th><th>Action(s)</th><th>[PDU Transfers]</th><th>New State</th></tr>
<tr><td>LRRc|r^0</td><td>RJN+bL</td><td>bpA</td><td></td><td></td></tr>
<tr><td></td><td>bL</td><td>bpA</td><td>[PDU_Out_UPM]</td><td></td></tr>
<tr><td></td><td>RJN+|bB</td><td>bpA, Pb=L</td><td>[PDU_Out_UPM]</td><td></td></tr>
<tr><td></td><td>ELSE</td><td>bpA, Pb=Nul</td><td>[PDU_Out_UPM]</td><td></td></tr>
<tr><td>LRRc^1</td><td>RJN|bL</td><td>bpA</td><td>[LNRr^1]</td><td></td></tr>
<tr><td></td><td>RJN+|bB</td><td>bpA, Pb=L</td><td>[LNRr^1]</td><td></td></tr>
<tr><td></td><td>ELSE</td><td>bpA, Pb=Nul</td><td>[LRRr^1]</td><td></td></tr>
<tr><td>LRRr^1</td><td>RJN+bL</td><td>IH_(RE), Va=Nr, TT1, ITi, Pr=L</td><td>[LPR^0]</td><td>LINK_RECOVERY</td></tr>
<tr><td></td><td>RJN+bR</td><td>IH_(RE), Pb=Nul, Va=Vs=Nr, TT1, ITi, Pr=L</td><td>[LPR^0]</td><td>LINK_RECOVERY</td></tr>
<tr><td></td><td>ELSE</td><td>IH_(RE), Va=Vs=Nr, TT1, ITi, Pr=L</td><td>[LPR^0]</td><td></td></tr>
<tr><td>LNRc|r^0</td><td>RJN+bL</td><td>bpA, Pb=B</td><td></td><td></td></tr>
<tr><td></td><td>bNul</td><td>bpA, Pb=R</td><td>[LRRr^0]</td><td></td></tr>
<tr><td></td><td>bL</td><td>bpA, Pb=B</td><td>[LNRr^0]</td><td></td></tr>
<tr><td></td><td>ELSE</td><td>bpA</td><td></td><td></td></tr>
<tr><td>LNRc^1</td><td>bNul</td><td>bpA, Pb=R</td><td>[LRRr^1]</td><td></td></tr>
<tr><td></td><td>bL</td><td>bpA, Pb=B</td><td>[LNRr^1]</td><td></td></tr>
<tr><td></td><td>bB</td><td>bpA</td><td>[LNRr^1]</td><td></td></tr>
<tr><td></td><td>ELSE</td><td>bpA</td><td>[LRRr^1]</td><td></td></tr>
<tr><td>LNRr^1</td><td>bL</td><td>IH_(RE), Pb=B, Va=Vs=Nr, TT1, ITi, Pr=L</td><td>[LPR^0]</td><td>LINK_RECOVERY</td></tr>
<tr><td></td><td>ELSE</td><td>IH_(RE), Pb=R, Va=Vs=Nr, TT1, ITi, Pr=L</td><td>[LPR^0]</td><td>LINK_RECOVERY</td></tr>
<tr><td>LRJc|r^0</td><td>RJN|bL</td><td>bpR</td><td>[PDU_Out_UPM]</td><td></td></tr>
<tr><td></td><td>bB</td><td>bpR, Pb=L</td><td>[PDU_Out_UPM]</td><td></td></tr>
<tr><td></td><td>ELSE</td><td>bpR, Pb=Nul</td><td>[PDU_Out_UPM]</td><td></td></tr>
<tr><td>LRJc^1</td><td>RJN</td><td>bpR</td><td>[LRRr^1]</td><td></td></tr>
<tr><td></td><td>RJN+|bL</td><td>bpR</td><td>[LNRr^1]</td><td></td></tr>
<tr><td></td><td>RJN+|bB</td><td>bpR, Pb=L</td><td>[LNRr^1]</td><td></td></tr>
<tr><td></td><td>ELSE</td><td>bpR, Pb=Nul</td><td>[LRRr^1]</td><td></td></tr>
<tr><td>LRJr^1</td><td>bB</td><td>bpR, Pb=L, Pr=L</td><td>[LPR^0]</td><td>LINK_RECOVERY</td></tr>
<tr><td></td><td>RJN+bR</td><td>IH_(RE), Pb=Nul, Va=Vs=Nr, TT1, ITi, Pr=L</td><td>[LPR^0]</td><td>LINK_RECOVERY</td></tr>
<tr><td></td><td>ELSE</td><td>IH_(RE), Va=Vs=Nr, TT1, ITi, Pr=L</td><td>[LPR^0]</td><td>LINK_RECOVERY</td></tr>
</table>

CHART 5-U: U-format LPDUs in LINK_OPENED State		
Stimuli P: V: ALT	Action(s) [PDU Transfers]	New State
LSM	IH, Vi=R, Vf=P, TT1, ITi	LINK_RESETING
LDC	IH, TT1, ITi [LUA']	LINK_CLOSED
LUA	IH_(RE), TT1, ITi, Pr=L [LPR°]	LINK_RECOVERY
LDM	IH, TT1, ITi	LINK_CLOSED
LPR	IH, TT1, ITi, Ct=0, Pr=R	LINK_RECOVERY
LXC	IH, Px=0, Vf=P	
LXR	IH_(RE), Px=Nul, TT1, ITi, Pr=R [LPR°]	LINK_RECOVERY
LTC	IH, Pt=0, Vf=P	
LTR	IH_(RE), Pt=Nul, TT1, ITi, Pr=R [LPR°]	LINK_RECOVERY

M.8.2.6 CHECKPOINTING State

CHART 6-E: EVENTS in CHECKPOINTING State				
Stimuli	P: V: ALT	Action(s)	[PDU Transfers]	New State
L3RDY		LE		
LSTRT		LE		
LSTOP	cNul	Pc=D		
	RJN+cR	Pc=D		
	ELSE	LE		
L3NOP		LE		
ELBSY	RJN+|cR	Pb=L, Pc=Nul		
	RJN+|bR	Pb=B, Pc=Nul		
	bL|B	LE		
	ELSE	Pb=L		
XLBSY	RJN+|bL	IH, Pb=Nul, Pc=R	[LRRr^0]	
	ELSE	LE		
XCHID	cNul+			
	xNul	Pc=X		
	x0	IH, Px=Nul	[LXR"]	
	xI0	IH, Px=I	[LXR"]	
	ELSE	LE		
LTEST	cNul+			
	tNul	Pc=T		
	t0	IH, Pt=Nul	[LTR"]	
	tI0	IH, Pt=I	[LTR"]	
	ELSE	LE		
SDATA		QL	[PDU_Out_UPM]	
ELPDU		IH_(RE), TT1, ITi, Pr=L	[LPR^0]	LINK_RECOVERY
ELT1X	t|x0	LE		
	t+x≠0	Ct=Ct+1		
	Ct=LN2	IH, IT1, ITi		LINK_CLOSED
	t+xNul	IT1	[LRRc^1]	
	x0|I0+			
	Ct<LN2	IT1	[LXC^1(id)]	
	t0|I0+			
	Ct<LN2	IT1	[LTC^1(data)]	
ELTiX		LE		

CHART 6-I: I-Format LPDUs in CHECKPOINTING State			
Stimuli P: V: ALT	Action(s)	[PDU Transfers]	New State
LIic|r^0 RJN+cR+ a<Vs	P=Pc=Nul, FB	[LRRr^0]	
a<Nr≤Vs	P=Pc=Nul, Va=Nr, FB	[LRRr^0]	
cR+ a<Vs	Pc=Nul, FB	[LRRr^0]	
a<Nr≤Vs	Pc=Nul, Va=Nr, FB	[LRRr^0]	
bL+a<Vs	DB	[LNRr^0]	
a<Nr≤Vs	Va=Nr, DB	[LNRr^0]	
RJN|RJN+bL a<Vs	P=Nul, FB	[LRRr^0]	
a<Nr≤Vs	Va=Nr, P=Nul, FB	[LRRr^0]	
ELSE a<Vs	FB	[LRRr^0]	
a<Nr≤Vs	Va=Nr, FB	[LRRr^0]	
LIic^1 RJN+cR+ a<Vs	P=Pc=Nul, FB	[LRRr^1]	
a<Nr≤Vs	P=Pc=Nul, Va=Nr, FB	[LRRr^1]	
cR+ a<Vs	Pc=Nul, FB	[LRRr^1]	
a<Nr≤Vs	Pc=Nul, Va=Nr, FB	[LRRr^1]	
bL+aNr<Vs	DB	[LNRr^1]	
a<Nr≤Vs	Va=Nr, DB	[LNRr^1]	
RJN|RJN+bL a<Vs	P=Nul, FB	[LRRr^1]	
a<Nr≤Vs	Va=Nr, P=Nul, FB	[LRRr^1]	
ELSE a<Vs	FB	[LRRr^1]	
a<Nr≤Vs	Va=Nr, FB	[LRRr^1]	
LIir^1	IP_(RE)		
LIec|r^0 cR+a<Vs	Pc=Nul, DB, P=RJN	[LRJr^0]	
a<Nr≤Vs	Pc=Nul, Va=Nr, DB, P=RJN	[LRJr^0]	
RJN+cR+ a<Vs	Pc=Nul, DB, P=RJN		
a<Nr≤Vs	Pc=Nul, Va=Nr, DB, P=RJN		
bL+a<Vs	DB, P=RJN	[LNRr^0]	
a<Nr≤Vs	Va=Nr, DB, P=RJN	[LNRr^0]	
RJN|RJN+bL+ a<Vs	DB		
a<Nr≤Vs	Va=Nr, DB		
ELSE a<Vs	DB, P=RJN	[LRJr^0]	
a<Nr≤Vs	Va=Nr, DB, P=RJN	[LRJr^0]	

CHART 6-I: I-Format LPDUs in CHECKPOINTING State (Continued)			
Stimuli P: V: ALT	Action(s)	[PDU Transfers]	New State
LIec[1] cR+a<Vs	Pc=Nul, DB, P=RJN	[LRJr[1]]	
a<Nr≤Vs	Pc=Nul, Va=Nr, DB, P=RJN	[LRJr[1]]	
RJN+cR+ a<Vs	Pc=Nul, DB, P=RJN	[LRRr[1]]	
a<Nr≤Vs	Pc=Nul, Va=Nr, DB, P=RJN	[LRRr[1]]	
bL+a<Vs	DB, P=RJN	[LNRr[1]]	
a<Nr≤Vs	Va=Nr, DB, P=RJN	[LNRr[1]]	
RJN+ a<Vs	DB	[LRRr[1]]	
a<Nr≤Vs	Va=Nr, DB	[LRRr[1]]	
RJN+bL+ a<Vs	DB	[LNRr[1]]	
a<Nr≤Vs	Va=Nr, DB	[LNRr[1]]	
ELSE a<Vs	DB, P=RJN	[LRJr[1]]	
a<Nr≤Vs	Va=Nr, DB, P=RJN	[LRJr[1]]	
LIer[1]	IP_(RE)		

CHART 6-S: S-format LPDUs in CHECKPOINTING State				
Stimuli P: V: ALT		Action(s)	[PDU Transfers]	New State
LRRc|r^{0} cR		Va=Nr		
RJN+¦bL+	a<Vs	NS	[LNRr^{0}]	
	a<Nr≤Vs	Va=Nr	[LNRr^{0}]	
RJN+bR+cR+	a<Vs	IH, Pb=Nul	[LNRr^{0}]	
	a<Nr≤Vs	IH, Pb=Nul, Va=Nr	[LNRr^{0}]	
ELSE	a<Vs	NS		
	a<Nr≤Vs	Va=Nr		
LRRc^{1} RJN+¦bL+	a<Vs	NS	[LNRr^{1}]	
	a<Nr≤Vs	Va=Nr	[LNRr^{1}]	
RJN+bR+cR+	a<Vs	IH, Pb=Nul	[LNRr^{1}]	
	a<Nr≤Vs	IH, Pb=Nul, Va=Nr	[LNRr^{1}]	
ELSE	a<Vs	NS	[LRRr^{1}]	
	a<Nr≤Vs	Va=Nr	[LRRr^{1}]	
LRRr^{1} cR		Va=Nr	[LRRc^{1}]	
RJN+¦bL+	a<Vs	NS		LINK_OPENED
	a<Nr≤Vs	Va=Nr		LINK_OPENED
RJN+bR+cR+	a<Vs	IH, Pb=Nul	[LRRc^{1}]	
	a<Nr≤Vs	IH, Pb=Nul, Va=Nr	[LRRc^{1}]	
ELSE	a<Vs	NS		LINK_OPENED
	a<Nr≤Vs	Va=Nr		LINK_OPENED

CHART 6-S: S-format LPDUs in CHECKPOINTING State (Continued)			
Stimuli P: V: ALT	Action(s)	[PDU Transfers]	New State
LNRc|r^0 bNul+cR	IH, Pb=R, Va=Nr		
bL+cR	IH, Pb=B, Va=Nr		
RJN+cR	IH, Pb=R, Va=Nr		
RJN+bL+ a<Vs	IH, Pb=B		
a<Nr≤Vs	IH, Pb=B, Va=Nr		
RJN+ a<Vs	IH, Pb=R		
a<Nr≤Vs	IH, Pb=R, Va=Nr		
ELSE a<Vs	NS		
a<Nr≤Vs	Va=Nr		
LNRc^1 bNul+cR	IH, Pb=R, Va=Nr	[LRRr^1]	
bL+cR	IH, Pb=B, Va=Nr	[LNRr^1]	
RJN+bL+ a<Vs	IH, Pb=B	[LNRr^1]	
a<Nr≤Vs	IH, Pb=B, Va=Nr	[LNRr^1]	
RJN|RJN+cR+ a<Vs	IH, Pb=R	[LRRr^1]	
a<Nr≤Vs	IH, Pb=R, Va=Nr	[LRRr^1]	
RJN+bR+cR+ a<Vs	NS	[LRRr^1]	
a<Nr≤Vs	IH, Va=Nr	[LRRr^1]	
ELSE a<Vs	NS	[LRRr^1]	
a<Nr≤Vs	Va=Nr	[LRRr^1]	
LNRr^1 bNul+cR	IH, Pb=R, Va=Nr	[LRRc^1]	
bL+cR	IH, Pb=B, Va=Nr	[LNRc^1]	
RJN+cR	IH, Pb=R, Va=Nr	[LNRc^1]	
RJN+bL+ a<Vs	IH, Pb=B		LINK_OPENED
a<Nr≤Vs	IH, Pb=B, Va=Nr		LINK_OPENED
RJN+ a<Vs	IH, Pb=R		LINK_OPENED
a<Nr≤Vs	IH, Pb=R, Va=Nr		LINK_OPENED
ELSE a<Vs	NS		LINK_OPENED
a<Nr≤Vs	Va=Nr		LINK_OPENED

CHART 6-S: S-format LPDUs in CHECKPOINTING State (Continued)				
Stimuli	P: V: ALT	Action(s)	[PDU Transfers]	New State
LRJc|r^0	cR+RJN+bL	Va=Nr		
	bL+a<Vs	NS		
	a<Nr≤Vs	Va=Nr		
	RJN+bR+cR+ a<Vs	IH, Pb=Nul		
	a<Nr≤Vs	IH, Pb=Nul, Va=Nr		
	ELSE a<Vs	NS		
	a<Nr≤Vs	Va=Nr		
$LRJc^1$	cR+aNR<Vs	IH	[$LRRr^1$]	
	a≤Vs	Va=Nr	[$LRRr^1$]	
	RJN+bL	Va=Nr	[$LNRr^1$]	
	bL+a<Vs	NS	[$LNRr^1$]	
	a<Nr≤Vs	Va=Nr	[$LNRr^1$]	
	RJN+cR+ a<Vs	NS	[$LRRr^1$]	
	a<Nr≤Vs	Va=Nr	[$LRRr^1$]	
	RJN+bR+cR+ a<Vs	IH, Pb=Nul	[$LRRr^1$]	
	a<Nr≤Vs	IH, Pb=Nul, Va=Nr	[$LRRr^1$]	
	ELSE a<Vs	NS	[$LRRr^1$]	
	a<Nr≤Vs	Va=Nr	[$LRRr^1$]	
$LRJr^1$	cR+RJN	Va=Nr	[$LRRC^1$]	
	bL+a<Vs	NS		LINK_OPENED
	a<Nr≤Vs	Va=Nr		LINK_OPENED
	RJN+bR+cR+ a<Vs	IH, Pb=Nul	[$LRRc^1$]	
	a<Nr≤Vs	IH, Pb=Nul, Va=Nr	[$LRRc^1$]	
	ELSE a<Vs	NS		LINK_OPENED
	a<Nr≤Vs	Va=Nr		LINK_OPENED

CHART 6-U: U-format LPDUs in CHECKPOINTING State			
Stimuli P: V: ALT	Action(s)	[PDU Transfers]	New State
LSM	IH, Vi=R, Vf=P, TT1, ITi		LINK_RESETING
LDC	IH, TT1, ITi	[LUA']	LINK_CLOSED
LUA	IH_(RE), TT1, ITi, Pr=L	[LPR^0]	LINK_RECOVERY
LDM	IH, TT1, ITi		LINK_CLOSED
LPR	IH, TT1, ITi, Ct=0, Pr=R		LINK_RECOVERY
LXC	IH, Vf=P, Px=R		
LXR^0|^1 cNul|R+ xNul|0	IH_(RE), TT1, ITi, Pr=L	[LPR^0]	LINK_RECOVERY
xI	IH, Px=Nul, RT1	[LRRc^1]	
xIO	IH, Px=0, RT1	[LRRc^1]	
cD	Pc=Nul, TTi, RT1, Ct=0	[LDC^1]	LINK_CLOSING
cX	Pc=Nul, Px=I, TTi, RT1, Ct=0	[LXC^1(id)]	
cT	Pc=Nul, Pt=I, TTI, RT1, Ct=0	[LTC^1(data)]	
LTC	IH, Vf=P, Pt=0		
LTR^0|^1 cNul|R+ tNul|0	IH_(RE), TT1, ITi, Pr=L	[LPR^0]	LINK_RECOVERY
tI	IH, Pt=Nul, RT1	[LRRc^1]	
tIO	IH, Pt=0, RT1	[LRRc^1]	
cD	Pc=Nul, TTi, RT1, Ct=0	[LDC^1]	LINK_CLOSING
cX	Pc=Nul, Px=I, TTi, RT1, Ct=0	[LXC^1(id)]	
cT	Pc=Nul, Pt=I, TTI, RT1, Ct=0	[LTC^1(data)]	

M.8.2.7 LINK_RESETING State

CHART 7-E: EVENTS in LINK_RESETING State			
Stimuli P: V: ALT	Action(s)	[PDU Transfers]	New State
L3RDY	LE		
LSTRT	Vi=P, Va=Vr=Vs=0, ITi	[LUA"]	LINK_OPENING
LSTOP	Vi=NUL, TT1, ITi	[LDM°]	LINK_CLOSED
L3NOP	LE		
ELBSY bNUL	Pb=L		
bR	Pb=B		
ELSE	LE		
XLBSY bNUL	LE		
XCHID	LE		
LTEST	LE		
SDATA	LE		
ELPDU	IH_(RE), TT1, ITi, Pr=L	[LPR°]	LINK_RECOVERY
ELT1X	NA		
ELTiX	IH, ITi		

CHART 7-I: I-Format LPDUs in LINK_RESETING State			
Stimuli P: V: ALT	Action(s)	[PDU Transfers]	New State
LIic	LE		
LIec	LE		
LIi|er	LE		

CHART 7-S: S-format LPDUs in LINK_RESETING State			
Stimuli P: V: ALT	Action(s)	[PDU Transfers]	New State
LRR|LNR|LRJ	IP		

CHART 7-U: U-format LPDUs in LINK_RESETING State		
Stimuli P: V: ALT	Action(s) [PDU Transfers]	New State
LSM	IH, Vf=P	
LDC	IH, Vi=Nul, TT1, ITi [LUA']	LINK_CLOSED
LUA	IH_(RE)	
LDM	IH, Vi=Nul, TT1, ITi	LINK_CLOSED
LPR	IH, Vi=NUL, TT1, ITi, Ct=0, Pr=R	LINK_RECOVERY
LXC	IP	
LXR	IP_(RE)	
LTC	IP	
LTR	IP_(RE)	

M.8.2.8 LINK_RECOVERY State

CHART 8-E: EVENTS in LINK_RECOVERY State				
Stimuli	P: V: ALT	Action(s)	[PDU Transfers]	New State
L3RDY		LE		
LSTRT		Vi=L, TTi, IT1, Ct=0	[LSM¹]	LINK_OPENING
LSTOP		TTi, IT1, Ct=0	[LDC¹]	LINK_CLOSING
L3NOP		LE		
ELBSY	bNul	Pb=L		
	bR	Pb=B		
	ELSE	LE		
XLBSY	bL	Pb=Nul		
	bB	Pb=R		
	ELSE	LE		
XCHID		LE		
LTEST		LE		
SDATA		LE		
ELPDU		IP		
ELT1X		LE		
ELTiX	rL	IH		
	rR	bpL	[Lo']	

CHART 8-I: I-Format LPDUs in LINK_RECOVERY State				
Stimuli	P: V: ALT	Action(s)	[PDU Transfers]	New State
LIc|r		DB	[LPR'(Vs,Vr,v)]	LINK_CLOSED

CHART 8-S: S-format LPDUs in LINK_RECOVERY State				
Stimuli	P: V: ALT	Action(s)	[PDU Transfers]	New State
LRR|LNR|LRJ		IP		

CHART 8-U: U-format LPDUs in LINK_RECOVERY State		
Stimuli P: V: ALT	Action(s) [PDU Transfers]	New State
LSM	IH, Pr=Nul, Vi=R, Vf=P, ITi	LINK_RESETING
LDC	IH, TT1, ITi [LUA']	LINK_CLOSED
LUA	IP	
LDM	IH, TT1, ITi	LINK_CLOSED
LPR	IH, Pr=R, TT1, ITi	
LXC	IP	
LXR	IP	
LTC	IP	
LTR	IP	

M.8.3 Basic Procedure Definitions

M.8.3.1 Acknowledgment

CHART A: Procedure for the ELLC Acknowledgment Processing		
Stimuli P: V: ALT	Action(s) [Frame Transfers]	New State
a<Nr<Vs	Va=Nr, RT1	
=Vs	Va=Nr, TT1, ITi	
ELSE	NS	

M.8.3.2 Limit

CHART L: Procedure for the ELLC Limit Processing		
Stimuli P: V: ALT	Action(s) [Frame Transfers]	New State
Ct=LN2	Ct='Ct+1' then IH, TT1, ITi	
ELSE	IT1	

M.8.3.3 Rejection

CHART R: Procedure for the ELLC Rejection Processing		
Stimuli P: V: ALT	Action(s) [Frame Transfers]	New State
a<Nr<Vs	Va=Nr, RT1	
=Vs	Va=Vs=Nr, TT1, ITi	
ELSE	Vs=Nr	

M.8.3.4 Link Test

CHART T: Procedure for the Link_Test Processing		
Stimuli P: V: ALT	Action(s) [Frame Transfers]	New State
c+x+tNul	Pt=I, TTi, RT1, Ct=0 [LTC[1]]	
c+xNul+tO	IH, Pt=Nul [LTR"]	
c+xNul+tIO	IH, Pt=I [LTR"]	
ELSE	LE	

M.8.3.5 Exchange Identification

CHART X: Procedure for the Exchange_Identification Processing		
Stimuli P: V: ALT	Action(s) [Frame Transfers]	New State
c+t+xNul	Px=I, TTi, RT1, Ct=0 [LXC¹]	
c+tNul+xO	IH, Px=Nul [LXR"]	
c+tNul+xIO	IH, Px=I [LXR"]	
ELSE	LE	

+ Appendix N. X.25_1980/1984/1988 Compatibility
+ Considerations

Restricted use of certain capabilities, formats and/or procedures
+ described in the 1984 "RED BOOK" version and the 1988 "BLUE BOOK"
+ version of CCITT Recommendation X.25 may be required for compatibility with specific implementations designed to comply with earlier versions of
+ the Recommendation. IBM SNA X.25_1984/1988 DTEs required to operate
+ with stations implemented in accordance with the 1980 "YELLOW BOOK"
+ version of CCITT Recommendation X.25 as described in GA27-3345-2, may
+ restrict the use of certain 1984/1988 capabilities as delineated in "PHYSICAL LAYER" through "CCITT-Specified DTE Facilities" on page N-9.

N.1 PHYSICAL LAYER

+ N.1.1 Differences between 1988 and 1984 X.25

+ N.1.1.1 Signaling Rates

+ American National Standards ANS X3.100 and Federal Information Proc-
+ essing Standard FIPS 100-1 require that all networks support data rates of
+ 4800 and 9600 kbits/s. They also specify 56 kbits/s as a standard rate in
+ North America and recommend it in place of the 48 kbits/s rate specified
+ in CCITT Recommendation X.1. Also, 64 kbits/s is recommended in
+ anticipatin of the Integrated Services Digital Networks (ISDN).

+ N.1.1.2 Access via ISDN B-Channel

+ CCITT Recommendation X.25 (1988) allows access to the network via an
+ Integrated-Services Digital Network (ISDN) B-Channel as specified in
+ CCITT Recommendation X.31. This is an optional capability.

+ N.1.2 Differences between 1984 and 1980 X.25

+ In addition to the differences listed above, the following items must be
+ taken into consideration to operate with the 1980 version of X.25.

+ N.1.2.1 V-Series Interface

+ Specific X.25_1984/1988 interface details, related particularly to failure
+ detection principles, loop testing and the use of specific circuits (Ref.
+ Section 1.3 of CCITT Recommendation X.25_1984/1988), are not included in
+ CCITT Recommendation X.25_1980.

- For 1980 operation, dependence on specific V-series procedures should be avoided except as "Network Specific" options.

N.2 DATA LINK LAYER

N.2.1 Differences between 1988 and 1984 X.25

N.2.1.1 DTE/DTE Operation

Although not specified in CCITT Recommendation X.25, International Standards Organization ISO 7776 supports communication between two DTEs without an intervening network. Since there is no intervening network, link layer characteristics must be made by bilateral agreement rather than at subscription time. This is an optional capability but is required if Open Systems-Interconnect (OSI) is supported.

N.2.1.2 Clearing a FRMR Condition at the DCE

After the DCE has transmitted a FRMR response, the frame rejection condition is cleared when the DCE receives a FRMR response (in addition to when a SABM/SABME, DISC, or DM is sent or received).

N.2.1.3 Maximum Number of Outstanding I-Frames

American National Standards ANS X3.100 specifies that all networks must support K=7. K is the maximum number of outstanding I-frames. This is required to claim conformance to ANS X3.100 or FIPS 100-1.

N.2.2 Differences between 1984 and 1980 X.25

In addition to the differences listed above, the following items must be taken into consideration to operate with the 1980 version of X.25.

N.2.2.1 Phase Synchronization

Initiation of the link disconnection procedure (i.e., transmission of a DISC command) by either X.25_1984/1988 station is specifically permitted, to insure 'Phase Synchronization' prior to initiation of the link set-up procedure (Ref. Section 2.4.4.1 of CCITT Recommendation X.25_1984/1988).

- For 1980 operation, the 'Phase Synchronization' procedure may be used only as a "Network Specific" option.

N.2.2.2 Initialization Phase

X.25_1984/1988 stations, having transmitted an SABM/SABME command, ignore and discard any frames received except an SABM/SABME or DISC command, or a UA or DM response (Ref. Section 2.4.4.1 of CCITT Recommendation X.25_1984/1988).

- For 1980 operation, specific implementations may treat received frames, containing other than SABM/SABME or DISC commands, or UA or DM responses differently since an 'Initialization Phase' was heretofore undefined.

Also, in the event of SABM/SABME command collisions, X.25_1984/1988 stations enter the information transfer phase either:

- after receiving the UA response,
- after sending the UA response, or
- after having sent a UA response and timing out waiting for the UA response

and accept a subsequent UA response received within the time-out interval as normal (Ref. Section 2.4.4.5.1 of CCITT Recommendation X.25_1984/1988.

- For 1980 operation, receipt of a UA response while in the information transfer phase may be treated as an exception condition resulting in initiation of either the link resetting or disconnection procedure.

N.2.2.3 Disconnection Phase

X.25_1984/1988 stations, having transmitted a DISC command, ignore and discard any frames received except an SABM/SABME or DISC command, or a UA or DM response (Ref. Section 2.4.4.3 of CCITT Recommendation X.25_1984/1988).

- For 1980 operation, specific implementations may treat received frames, containing other than SABM/SABME or DISC commands, or UA or DM responses differently since a 'Disconnection Phase' was heretofore undefined.

Also, in the event of DISC command collisions, X.25_1984/1988 stations enter the disconnected phase either:

1. after receiving the UA response,
2. after sending the UA response, or
3. after having sent a UA response and timing out waiting for the UA response

and accept a subsequent UA response received within the time-out interval as normal (Ref. Section 2.4.4.5.1 of CCITT Recommendation X.25_1984/1988.

- for 1980 operation, stations enter the disconnected phase only after receipt of a UA response or after sending a UA response and timing out waiting for a UA response.

N.2.2.4 Rejection Recovery

Duplicate re-transmission of the I-frames within the same numbering cycle, by X.25_1984/1988 stations, is specifically prohibited (Ref. Section 2.4.5.9 of CCITT Recommendation X.25_1984/1988).

- For 1980 operation, duplicate I-frame re-transmissions within the same numbering cycle are ignored.

N.2.2.5 Extended Frame Sequencing Mode

An optional extended mode of station operation, wherein frame sequencing may be performed modulo 128, is defined for X.25_1984/1988 stations (Ref. Section 2.4 of CCITT Recommendation X.25_1984/1988).

- For 1980 operation, stations are restricted to the Basic Mode of operation wherein frame sequencing is performed modulo 8.

N.2.2.6 Multi-link Procedures (MLP) (Subscription-time Selectable Option)

+ X.25_1984/1988 stations may use an optional MLP to distribute outgoing
+ packets across the SLPs available at the origin DTE/DCE interface and re-sequence incoming packets received from the SLPs at the destination DTE/DCE interface for delivery to the packet layer (Ref. Sections 2.1 and
+ 2.5 of CCITT Recommendation X.25_1984/1988).

- For 1980 operation, the multi-link procedures cannot be used.

N.2.2.7 Flag Sequences

+ Sequences of contiguous flags transmitted by X.25_1984/1988 stations are
+ restricted to complete 8-bit flag sequences (e.g., '011111100111...1110')
+ (Ref. Section 2.2.2 of CCITT Recommendation X.25_1984/1988).

- For 1980 operation, stations may be required to recognize shared '0' bit flag sequences (e.g., '011111101111110...01111110') as well as multiple complete 8-bit flag sequences (e.g., '011111100111...1110') as sequences of contiguous flags.

N.3 PACKET LAYER

+ N.3.1 Differences between 1988 and 1984 X.25

+ N.3.1.1 Network User Identification (NUI)

+ Network_User_Identification (NUI) related facilities has been divided into
+ three optional facilities:

+ NUI_subscription

+ NUI_override

+ NUI_selection

+ N.3.1.2 DTE/DTE Operation

+ DTE to DTE operation without an intervening network has been defined. In
+ this situation, one DTE must act as DCE. The DTE acting as DCE at packet
+ layer may be acting as DTE at Data Link Layer and vice versa. This is an
+ optional facility but is required to support Open Systems Interconnect
+ (OSI).

+ N.3.1.3 Circuit-switched Connection without Prior Agreement

+ A circuit-switched connection without prior agreement (such as electronic
+ mail-order) has been defined and default values specified for all appli-
+ cable parameters. This is an optional capability.

+ N.3.1.4 Throughput Class of 64000 bits/s

+ A new throughput class of 64000 bits per second has been defined. This
+ is an optional capability.

+ ### N.3.1.5 Address Block Definition

+ A new Address Block has been defined for call setup and clearing packets
+ which allows addresses of 12 or 15 digits. This is an optional capability.

+ ### N.3.1.6 TOA/NPI Address Subscription

+ A new facility, TOA/NPI_Address_Subscription, has been added to accom-
+ modate E.164 (ISDN) addresses of up to 17 digits in length. This addition
+ results in a redefinition of the "address block" and the consequent defi-
+ nition of new formats for the CALL_REQUEST, CALL_ACCEPTED,
+ CALL_CONNECTED, CLEAR_REQUEST, CLEAR_INDICATION, and
+ CLEAR_CONFIRMATION packets. This is an optional capability.

+ ### N.3.1.7 Call_Deflection

+ Call_Deflection_Selection facilities whereby the DTE forwards calls after
+ receiving an INCOMING_CALL packet (unlike Call_Redirection which is
+ handled in the network and the originally called DTE never receives an
+ INCOMING_CALL packet) has been added. There are three call deflection
+ facilities:

+ Call_Deflection_Subscription which enables the DTE to request
+ Call_Deflection_Selection.

+ Call_Deflection_Selection which may be used on a per virtual call
+ basis only if Call_Deflection_Subscription has been subscribed to.

+ Call_Deflection_Notification which informs the alternate DTE that the
+ call has been forwarded.

+ These are optional user facilities.

+ ### N.3.1.8 Priority Facility

+ A Priority Facility has been added to specify the priority of data on a con-
+ nection, priority to gain a connection, and priority to keep a connection.
+ This is an optional capability.

+ ### N.3.1.9 Protection Facility

+ A Protection Facility has been added to allow specification of a protection
+ code. This is an optional capability.

+ ### N.3.1.10 Maximum size of Called and Calling Address Extension

+ The maximum size of the called and calling address extension fields are
+ extended from 32 to 40 digits and an OSI/non-OSI indicator has been
+ added. Support of the larger address is optional. However, a test of the
+ OSI/non-OSI indicator is required to determine the size of the called and
+ calling addresses.

+ ### N.3.1.11 Recognized_Private_Operating_Agency (RPOA)

+ RPOA related facilities have been divided into two facilities:

+ RPOA_Subscription which applies to all virtual calls

+ RPOA_Selection which applies to a given virtual call and does not
+ require RPOA_Subscription.

+ These are optional capabilities.

+ ### N.3.1.12 Mandatory Address Length Fields in CALL_ACCEPTED packets

+ The use of the Address Length Fields in CALL_ACCEPTED packets is mandatory, even if they are set to zero.

+ ### N.3.1.13 Mandatory Facility Length Fields in CALL_ACCEPTED packets

+ The use of the Facility Length Fields in CALL_ACCEPTED packets is mandatory, even if they are set to zero.

+ ### N.3.1.14 Virtual Circuit Clearing/Resetting Failure

+ • When a CLEAR_REQUEST packet is not confirmed within time-limit T23, the DTE will retry the call clearing procedure up to R23 times, at T23 intervals, before notifying the higher layer (virtual circuit user) of the failure; leaving the logical channel in the DTE_CLEAR_REQUEST state (p6) rather than "placing the logical channel in an inoperative state" as specified by earlier versions of this document.

+ • When a RESET_REQUEST packet is not confirmed within time-limit T22, the DTE will retry the resetting procedure up to R22 times, at T22 intervals, before notifying the higher layer (virtual circuit user) of the failure; leaving the logical channel in the DTE_RESET_REQUEST state (d2), rather than "placing the logical channel in an inoperative state" as specified by earlier versions of this document.

+ These changes are mandatory.

+ ## N.3.2 Differences between 1984 and 1980 X.25

+ In addition to the differences listed above, the following items must be taken into consideration to operate with the 1980 version of X.25.

+ ### N.3.2.1 Expanded User Data Fields

+ DATA packets transmitted by X.25_1984/1988 stations may include up to 2048 and 4096 octets of User_Data (Ref. Sections 4.3.2, 6.9, 6.12 and 7.2.2.1.1 of CCITT Recommendation X.25_1984 or 1988);

- For 1980 operation, DATA packets are limited to a maximum of 1024 octets of User Data.

N.3.2.2 Expanded Facility Fields

Facilities transmitted in CALL_REQUEST, INCOMING_CALL,
+ CALL_ACCEPTED, and CALL_CONNECTED packets by X.25_1984/1988 stations may include up to 109 octets (Ref. Sections 5.2.1, 5.2.2, 5.2.3 and 5.2.4 and Figures 2/X.25, 3/X.25, 4/X.25 and 5/X.25 of CCITT Recommendation X.25_1984/1988);

- For 1980 operation, facilities are limited to 63 octets and bit 7 as well as bit 8 of the Facility Length must be set equal to '0';

N.3.2.3 Expanded DTE Cause Codes

+ 'DTE-Originated' cause codes transmitted by X.25_1984/1988 stations, in CLEAR_REQUEST, CLEAR_INDICATION, RESET_REQUEST, RESET_INDICATION, RESTART_REQUEST and RESTART_INDICATION packets, may have the value x'00'; or, x'80' (Ref. Sections 5.2.3, 5.4.3 and
+ 5.5.1 and Tables 18/X.25, 19/X.25 and 20/X.25 of CCITT Recommendation
+ X.25_1984/1988);

- For 1980 operation, the 'DTE-Originated' cause code is restricted to the value x'00'.

N.3.2.4 Restricted Address and Facility Lengths

CLEAR_REQUEST and CLEAR_INDICATION packets transmitted by X.25_1984/1988 stations may include non-zero Address and Facility Length Fields (Ref. Section 5.2.3.2 and Figure 4/X.25 of CCITT Recommendation X.25_1984/1988);

- For 1980 operation, these length fields are permitted only when the packet contains Clear_User_Data and must indicate zero octets;

N.3.2.5 Extended DCE_CLEAR_CONFIRMATION packets

An extended format for DCE_CLEAR_CONFIRMATION packets is defined for use by X.25_1984/1988 DCEs in conjunction with the Charging_Information facility described in section 6.22 of CCITT Recommendation X.25_1984/1988 (Ref. Section 5.2.4 and Figure 5/X.25 of CCITT Recommendation X.25_1984/1988);

- For 1980 operation, DCE_CLEAR_CONFIRMATION packets are restricted to basic format which does not include facilities.

N.3.2.6 Extended Interrupt User Data Fields

INTERRUPT packets transmitted by X.25_1984/1988 stations may include up to 32 octets of User_Data (Ref. Section 5.3.2 and Figure 7/X.25 of CCITT Recommendation X.25_1984/1988);

- For 1980 operation, INTERRUPT packets include exactly one octet of User Data.

N.3.2.7 Time-Out Retry Procedures

When packet layer operations are to be retried (as specified in Table D-2), they are retried by X.25 stations '$n \geq 1$' times following expiration of system specified time-outs (REF. Annex D to CCITT Recommendation X.25_1984/1988;

- For 1980 operation, packet layer operations may be retried '$n \geq 0$' times following expiration of system specified time-outs.

N.3.3 Additional Optional User Facilities

New optional user facilities that may be used by X.25_1984/1988 stations include:

- On-line Facility Registration (Ref. Section 6.1 of CCITT Recommendation X.25_1984/1988),
- Local Charging Prevention (Ref. Section 6.20 of CCITT Recommendation X.25_1984/1988),
- Network User Identification (Ref. Section 6.21 of CCITT Recommendation X.25_1984/1988),
- Charging Information (Ref. Section 6.22 of CCITT Recommendation X.25_1984),
- Hunt Group (Ref. Section 6.24 of CCITT Recommendation X.25_1984/1988),
- Call Redirection (Ref. Section 6.25 of CCITT Recommendation X.25_1984/1988),

- Called Line Address Modified Notification (Ref. Section 6.26 of CCITT Recommendation X.25_1984/1988),
- Call Redirection Notification (Ref. Section 6.27 of CCITT Recommendation X.25_1984/1988), and
- Transit Delay Selection and Indication (Ref. Section 6.28 of CCITT Recommendation X.25_1984/1988),

  – For 1980 operation, none of the Optional User Facilities listed above can be used;

N.3.4 Expanded Capabilities.

Expanded capabilities for some optional user facilities that may be used by X.25_1984/1988 stations include:

1. Closed User Groups (CUG): X.25 (1984/1988) DTEs may be able to subscribe to:

   a. the Closed User Group with Outgoing Access and/or Incoming Access Facilities without designating a preferential CUG (Ref. Sections 6.14.2 and 6.14.3, respectively, of CCITT Recommendation X.25_1984/1988;
   b. the use of the extended format of the CUG Selection Facility for indicating membership in more than 100 CUGs (Ref. Section 6.14.6 of CCITT Recommendation X.25_1984/1988); and
   c. the use of the Closed User Group with Outgoing Access (CUG/OA) Selection Facility (Ref. Section 6.14.7 of CCITT Recommendation X.25_1984/1988).

      - For 1980 operation, all CUG subscriptions require a preferential CUG; only the basic format of the CUG Selection Facility, which restricts membership in 100 or less CUGs, is allowed; and, the CUG/OA Selection Facility cannot be used,

2. Fast Select and Fast Select Acceptance (Ref. Sections 6.16 and 6.17, respectively, of CCITT Recommendation X.25_1984): CLEAR_REQUEST and CLEAR_INDICATION packets transmitted by X.25 (1984/1988) stations after call setup has been completed may include Clear_User_Data (Ref. Section 5.2.3.2 and Figure 4/X.25 of CCITT Recommendation X.25_1984/1988);

   - For 1980 operation, Clear_User_Data may be included in CLEAR_REQUEST and CLEAR_INDICATION packets only when sent or received in direct response to an INCOMING_CALL or a CALL_REQUEST packets, respectively, and

3. RPOA Selection (Ref. Section 6.23 of CCITT Recommendation X.25_1984/1988): X.25_1984/1988 DTEs may be able to use an extended format of the RPOA Selection Facility to select one or more RPOAs, and agreement for a period of time with the DCE to a set of RPOAs to pertain to all CALL_REQUEST packets;

   - For 1980 operation, RPOA Selection is limited to CALL_REQUEST packets and can only use the basic format of the RPOA Selection Facility to select a single RPOA; and

N.3.5 CCITT-Specified DTE Facilities

The CCITT-specified DTE facilities, described in Appendix G, "CCITT-Specified_DTE Facilities," that X.25_1984/1988 may be able to use, include:

1. Calling DTE Address Extension (Ref. Annex G.3.1 of CCITT Recommendation X.25_1984/1988),
2. Called DTE Address Extension (Ref. Annex G.3.2 of CCITT Recommendation X.25_1984/1988),
3. Quality of Service Negotiation (Ref. Annex G.3.3 of CCITT Recommendation X.25_1984/1988),
4. Expedited Data Negotiation (Ref. Annex G.3.4 of CCITT Recommendation X.25_1984/1988):
   - For 1980 operation, use of any of these 'CCITT-Specified DTE Facilities' and the associated Facility Marker (see "General" on page 7-1), x'0F', is prohibited.

Appendix O. Description of the BNN_Qualified Logical Link Control - (QLLC) Procedures

QLLC provides adjacent SNA node physical services where such nodes are connected through 'X.25-based' PSDN services. It uses HDLC unnumbered and supervisory Receive_Ready commands and responses, identical to their SDLC counterparts, carried as User_Data in Q-packets. QLLC commands and responses are initiated by the same higher layer events that initiate their SDLC counterparts; timeout processing, as in SDLC, may be required for all QLLC commands.

QLLC procedures are defined for balanced (peer-to-peer), primary, and secondary link station configurations.

In peer-to-peer QLLC, either link station may initiate actions (i.e., transmit commands); HDLC asynchronous balanced mode (ABM) functions are utilized for peer-to-peer QLLC.

In primary/secondary QLLC, only primary link stations initiate actions. HDLC normal response mode (NRM) functions are utilized for primary/secondary QLLC where primary link stations transfer commands to which secondary link stations respond. Secondary stations may also transfer the QRD response asynchronously to solicit initiation of the disconnection procedure by the primary link station.

Procedures for use of the QLLC protocols by balanced, primary, and secondary link stations are described in this section. In addition, some stations may function as 'combined', or 'configurable' stations that exhibit balanced characteristics until role negotiation is completed via exchanges of identification information. After such role negotiation is completed, 'combined' or 'configurable' QLLC link stations assume the role and functions of either primary or secondary depending on the outcome of the role negotiation process.

O.1 Introduction

QLLC is the 'base architecture' for logical link control to be provided by all IBM SNA X.25 DTEs, except the 5973 NIA and the 5251-M12. It uses X.25 DATA packets with the 'Qualifier Bit' equal to one ('Q = 1'), also referred to as 'Q-packets', to transfer HDLC-like commands and responses.

QLLC is used by two adjacent link stations to exchange elementary units of information over link connections in one of several environments: peer-to-peer, primary/secondary, or indirectly coupled; the environments are illustrated in Figure O-1 on page O-3. One link station acts as either a peer or primary link station, associated with a DTE attached to a PSDN via an X.25 DTE/DCE interface, and communicates with another link station, associated with a partner DTE attached to the same or some other interconnected PSDN, which acts as either a peer or secondary link station, respectively.

In indirectly coupled configurations, a packet assembly/disassembly (PAD) function, provided either by the PSDN or as a stand-alone interface adapter, acts as the 'REMOTE DTE' and correlates actions that take place across the link connection to actions that take place across the access link connecting the interface adapter and the secondary link station. In this environment the secondary link station is referred to as the 'Related Secondary Station' (RSS).

The objective of QLLC is to provide adjacent node physical services equivalent to those used by SDLC in SNA. It helps to keep the 'LOCAL DTE' informed of the situation in the 'REMOTE DTE' and/or the 'Related Secondary Station'. Segmentation and concatenation of DATA packets may be performed by the packet layer procedures at both ends of the link connection by means of the More Data Mark 'M-bit' procedures defined in "More Data Mark" on page 4-9.

The basic elements of information exchanged are called Logical Link Units (LLUs). Two types of LLUs are defined:

QLLUs - composed of commands or responses which together with their uses and the resultant actions performed by link stations at both the local and remote DTEs are described in "QLLC Commands and Responses" on page O-9. QLLUs are conveyed between adjacent link stations in Q-packets formatted as shown in Figure O-2 on page O-8.

DLLUs - appearing as SNA Basic Transmission Units (BTUs), and carried in the User_Data field of X.25 DATA packets with the 'Q = 0' and the 'M = 0 or 1', are used to convey user data between adjacent link stations in local and remote DTEs as described in "DTE and DCE_DATA Packets" on page 5-20.

X.25 Delivery Confirmation 'D-bit' procedures are not used.

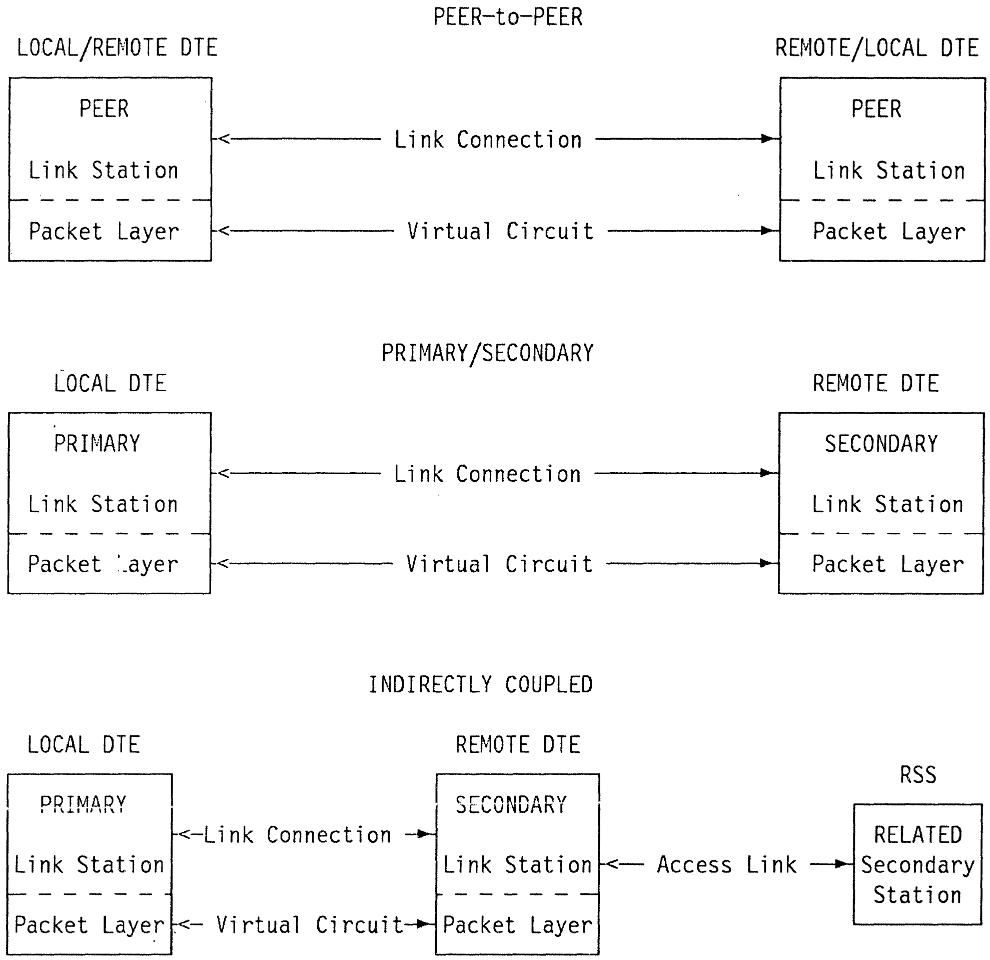


Figure O-1. Qualified Logical Link Control Station Configurations

O.2 Elements of Procedure

The elements of procedure for QLLC include states, predicate conditions, external stimuli, Q-packet formats, commands, responses, and function descriptions.

Link connections are perceived by link stations as being in one of six states (see "States" on page O-4) at any particular instant in time.

Predicate conditions are protocol variables (see "Predicate Condition" on page O-5) that influence the specific procedures performed in the various states.

External stimuli are station events (see "External Stimuli" on page O-6) that are inputs to the QLLC finite state machines. The Receive_Data and Send_Data events are data received or data to be transmitted, respectively, while Erroneous_QLLU signifies a received Q_packet that contains an unrecognizable command or response. All other stimuli are local events.

Q-packet formats (see "Q-Packet Formats" on page O-7) define qualified data packets which carry QLLC commands and responses between link stations in adjacent nodes.

Function descriptions (see "Function descriptions" on page O-13) are expanded definitions of some of the functions specified by the QLLC finite state machine; other functions are self explanatory.

O.2.1 States

O.2.1.1 CLOSED

The CLOSED state is the initial operational state. Link stations having transmitted or received a QDISC command QLLU and received or transmitted a QUA response QLLU, respectively, perceive the link connection to be in the CLOSED state. Peer and primary link stations complete exchange of identification information (QXID), or link test (QTEST) procedures, on behalf of the higher layer, across link connections perceived to be in this state. Some may also initiate a link set-up procedure (transmit a QSM command). Secondary link stations accept and respond to QXID and QTEST commands received across link connections perceived to be in this state. Some may also accept and respond to QSM commands.

O.2.1.2 CLOSING

Link stations having initiated a link disconnection procedure (transmitted a QDISC command or QRD response) perceive the link connection to be in the CLOSING state until the link disconnection procedure is successfully completed or terminated unsuccessfully. Peer, primary and secondary link stations await successful completion or unsuccessful termination of link connections in this state.

O.2.1.3 INOPERATIVE (INOP)

The INOPERATIVE state is the initial state. Link connections are perceived by link stations to be in an INOPERATIVE state when the supporting virtual circuit is inoperative. Peer, primary and secondary link stations on link connections perceived to be in this state neither transmit nor receive QLLUs or DLLUs and require a higher layer stimulus to become operational.

O.2.1.4 OPENED

Link stations having transmitted or received a QSM command QLLU and having received or transmitted, respectively, a QUA response QLLU perceive the link station to be in the OPENED state. QLLUs and DLLUs may be transmitted and received both by the called and link stations across link connections perceived to be in this state.

O.2.1.5 OPENING

Link stations participating in the link set-up procedure perceive the link connection to be in the OPENING state until that procedure is successfully completed or terminated unsuccessfully. Peer and primary link stations, having transmitted a set mode (QSM) command across the link connection expect to receive a response (QUA or QDM) within a user specified time-limit. Peer link stations also respond (QUA) to set mode (QSM) commands received across link connections perceived to be in this state at the first opportunity. Secondary link stations accept and respond (QUA) to set mode (QSM) commands received across link connections perceived to be in this state at the first opportunity.

O.2.1.6 RECOVERY

The RECOVERY state is comparable to the data link layer frame rejection phase. Peer and secondary link stations retransmit the QFRMR response on link connections perceived to be in this state at each respond opportunity until recovery is effected by the adjacent link station, or until internal recovery is initiated locally. A primary link station does not have a RECOVERY state.

O.2.2 Predicate Condition

The values that may be assigned to the predicate condition are:

O.2.2.1 Contact Termination Pending (CTp)

Represents the secondary link station condition in which receipt of a DLLU or a Receive Ready (QRR) command QLLU from the primary link station is required to terminate the SNA_CONTACT phase on link connections perceived to be in the OPENING state.

O.2.2.2 Incoming/Outgoing TEST Response Pending (IOTRp)

Transmission and receipt of TEST response QLLUs containing test patterns to and from the link station in the adjacent node are pending.

O.2.2.3 Incoming/Outgoing XID Response Pending (IOXRp)

Transmission and receipt of XID response QLLUs containing link station identification information to and from the link station in both adjacent nodes are pending.

O.2.2.4 Incoming TEST Response Pending (ITRp)

Receipt of a TEST response QLLU containing the test pattern from the link station in the adjacent node is pending.

O.2.2.5 TEST/XID Response Pending (ITOXRp)

Receipt of a TEST response QLLU containing the test pattern from and an XID response QLLU containing link station identification information to the link station in the adjacent node are both pending.

O.2.2.6 XID/TEST Response Pending (IXOTRp)

Receipt of an XID response QLLU containing link station identification information from and transmission of a TEST response QLLU containing the test pattern to the link station in the adjacent node are both pending.

O.2.2.7 Incoming XID Response Pending (IXRp)

Receipt of an XID response QLLU containing link station identification information from the link station in the adjacent node is pending.

O.2.2.8 No Predicate Condition (NULL)

Signifies that no transient predicate condition exists to alter the action required of the link station.

O.2.2.9 Outgoing TEST Response Pending (OTRp)

Transmission of a TEST response QLLU containing the test pattern to the link station in the adjacent node is pending.

O.2.2.10 Outgoing XID Response Pending (OXRp)

Transmission of an XID response QLLU containing link station identification information to the link station in the adjacent node is pending.

O.2.2.11 Remote RESTART Pending (RRp)

A restart of the packet layer interface providing remote DTE access to the network is pending.

O.2.2.12 SET_MODE Pending (SMp)

Some QLLC link stations (see note 1 in the QLLC_FSM) are permitted to complete link initialization only after a successful exchange of identification information; these stations use the predicate condition value of SMp.

O.2.3 External Stimuli

O.2.3.1 Erroneous_QLLU

Represents receipt of an erroneous qualified logical link unit (QLLU) (e.g.,
+ a Q_PACKET containing an unidentifiable or not supported command or
+ response or information field too long) on the link connection.

O.2.3.2 Exchange_Identification

Represents a higher layer request for or authorization to transfer logical link identification information.

O.2.3.3 Link_Start

Represents a higher layer stimulus to initiate the logical link control set-up procedure for the link connection.

O.2.3.4 Link_Stop

Represents a higher layer stimulus to initiate the logical link control disconnection procedure for the link connection.

O.2.3.5 Link_Test

Represents a higher layer request for or authorization to transfer link test data.

O.2.3.6 Link_Timeout_Expiration

Represents expiration of link reply timeout, Timer Tq.

O.2.3.7 Packet_Layer_Inoperative

Represents a signal from the packet layer that the underlying virtual circuit is inoperative.

O.2.3.8 Packet_Layer_Ready

Represents a signal from the packet layer that the underlying virtual circuit is in the READY state.

O.2.3.9 Receive_Data

Represents the receipt of a data logical link unit (DLLU) from the adjacent logical link station.

O.2.3.10 Send_Data

Represents a higher layer request for the transfer of a data logical link unit (DLLU) to the adjacent logical link station.

O.2.3.11 Virtual_Circuit_Clear_Reset

Represents a packet layer clearing of the virtual call, or resetting of the permanent virtual circuit, supporting the link connection.

+ O.2.3.12 Effects of LAPB Link Resetting

+ Resetting of the data link layer re-initializes LAPB sequence numbering and constitutes an exposure to the integrity of data for either direction of transmission. Such exposures cannot be resolved by logical link stations using QLLC which is required to:

- report, an outage for each virtual circuit supported by the LAPB link, to a higher layer of SNA; and,
- remove affected vitrual circuits from service by clearing virtual calls and resetting permanent virtual circuits.

O.2.4 Q-Packet Formats

'Q-packets' used by QLLC conform to one of the formats depicted in Figure O-2 on page O-8.

Bits

Octet	8	7	6	5	4	3	2	1
1	General format identifier (GFI)				Logical channel group number			
	1	0	0	1				
2	Logical channel number							
3	Pr			M	Ps			0
4	QLLC Address Field (Coded x'FF' for Commands or ≠ x'FF' for Responses)							
5	QLLC Control Field							
6 • n	QXID/QTEST/QFRMR Information Field (Optional)							

(Modulo 8)

Bits

Octet	8	7	6	5	4	3	2	1
1	General format identifier (GFI)				Logical channel group number			
	1	0	1	0				
2	Logical channel number							
3	Ps							0
4	Pr							M
5	QLLC Address Field (Coded x'FF' for Commands or ≠ x'FF' for Responses)							
6	QLLC Control Field							
7 • n	QXID/QTEST/QFRMR Information Field (Optional)							

(Modulo 128)

M = More Data Mark

Figure O-2. QUALIFIED_DATA Packet Formats

O.2.4.1 QLLC Address Field

The address field consists of one octet. The contents of the address field is set to x'FF' in 'Q-packets' containing commands and to any value other than x'FF' in 'Q-packets' containing responses.

O.2.4.2 QLLC Control Field

The control field consists of one octet. The control field contains the command/response transmitted by the peer, primary or secondary link station as depicted in Figure O-3.

O.2.4.3 QLLC Information Field

The information field consists of a variable number of octets and is used to carry QXID, QTEST or QFRMR data.

O.2.5 QLLC Commands and Responses

Figure O-3 shows the code points for the HDLC commands/responses carried in Q-packets used by peer, primary and secondary QLLC link stations.

QLLC Function	C-Field Hex Octet 1	I-Field Allowed	Primary Command	Secondary Response	Peer-to-Peer	
					Command	Response
QSM	93	NO	X		X	
QDISC	53	NO	X		X	
QXID	BF	YES	X		X	
QTEST	F3	YES	X		X	
QRR	F1	NO	X		X	
QRD	53	NO		X		
QXID	BF	YES		X		X
QTEST	F3	YES		X		X
QUA	73	NO		X		X
QDM	1F	NO		X		X
QFRMR	97	YES		X		X
Note: The Address field as defined for SDLC is octet '0'.						

Figure O-3. DTE and DCE DATA Packet User_Data Field Format

O.2.5.1 Q_Disconnect (QDISC)

The Disconnect command QLLU is transferred by peer and primary QLLC link stations to place the link connection, as perceived by the peer or secondary QLLC link station in the adjacent node, in the CLOSED state. No information field is permitted with the QDISC command.

Upon receipt of the DISC command QLLU peer and secondary QLLC link stations, on link connections perceived to be in other than the CLOSED state, transfer a UA response QLLU confirming acceptance of the QDISC command and place the link connection in the CLOSED state. Link connections perceived to be in the CLOSING state, by peer and primary QLLC link stations, are placed in the CLOSED state upon receipt of a UA response QLLU by that QLLC link station.

O.2.5.2 Q_Disconnected_Mode (QDM)

The Disconnected_Mode response QLLU may be transferred by peer and secondary QLLC link stations in response to QSM or QDISC commands. No information field is permitted with the QDM response.

Receipt of a QDM response informs the receiving peer or primary QLLC link station that the link connection, as perceived by the communicating QLLC link station in the adjacent node, is in the CLOSED state.

O.2.5.3 Q_Frame_Reject (QFRMR)

The Frame_Reject response QLLU may be used by peer and secondary QLLC link stations to inform the communicating QLLC link station in the adjacent node of an error condition that cannot be recovered at the LLC layer, by retransmission of the identical LLU.

Upon receipt of a QFRMR response, peer and primary QLLC link stations cause a clearing of the VC or a resetting of the PVC supporting the link connection and inform a higher layer SNA protocol of the failure. The format of the information field of the Frame_Reject response QLLU is depicted in Figure O-4 on page O-11.

I-field bits 1 2 ...... 7 8	9	10 11 12	13	14 15 16	17	18	19	20	21	22	23	24
Rejected LLU Control Field	0	Vs	Note	Vr	W	X	Y	Z	0	0	0	0

- Rejected LLU control field is the control field of the received LLU that caused the frame reject.
- Vs is reserved and set to b'000'.
- Vr is reserved and set equal to b'000'.
- 'W=1' indicates that the control field received and returned in bits 1 through 8 was considered invalid or not implemented.
- 'X=1' indicates that the control field received and returned in bits 1 through 8 was considered invalid because the LLU contained an information field which is not permitted or is an S or U-frame with incorrect length. 'W=1' in required in conjunction with this bit.
- 'Y=1' indicates that the information field received exceeded the maximum established capacity of the link station reporting the rejection condition.
- 'Z' is reserved and set equal to b'0'.

Note: Bit 13 is set to:

'1' if the LLU rejected was a response; or,
'0' if the LLU rejected was a command.

Figure O-4. QFRMR Information Field Format

O.2.5.4 Q_Receive_Ready (QRR)

The Receive_Ready command QLLU may be transferred by peer and primary QLLC link stations to indicate that the link connection is in the OPENED state and the QLLC link stations are prepared to accept and respond to DLLUs.

O.2.5.5 Q_Request_Disconnect (QRD)

The Request_Disconnect response QLLU may be used by secondary QLLC link stations to request the primary QLLC link station to place the link connection as perceived by the secondary QLLC link station in the CLOSED state (i.e., initiate the link disconnection procedure by transferring a QDISC command across the link connection). As a result of receiving a DISCONTACT or similar request from a higher SNA layer, secondary QLLC link stations may transfer a QRD response, when no other responses (such as acknowledgments for received DLLUs or responses to received Unnumbered commands) are pending. The QRD response may be retransmitted a user specified number of times. DLLUs received by the secondary QLLC link station after transmission of the QRD response and prior to receipt of the requested QDISC command are accepted and responded to in the normal way. No information field is permitted with the QRD response.

Upon receipt of a QRD response the primary QLLC link station will transfer a QDISC command when authorized by a higher layers of SNA.

O.2.5.6 Q_Set_Mode (QSM)

The Set_Mode command QLLU is transmitted by peer and primary link stations to place the link connection, as perceived by the link station in the adjacent node, in the OPENED state. No information field is permitted with the QSM command.

Upon receipt of the Set_Mode command QLLU peer and secondary QLLC link stations, authorized by the higher layers of SNA, transfer a UA response QLLU confirming acceptance of the QSM command and place the link connection in the OPENED state. Peer and primary QLLC link stations, having transferred a Set_Mode command QLLU place the link connection in the OPENED state upon receipt of the UA response QLLU from the peer or secondary QLLC link station in the adjacent node.

O.2.5.7 Q_Test_Command and Q_Test_Response (QTEST)

The TEST command QLLU may be issued by peer and primary QLLC link stations at any time to solicit a TEST response QLLU from the peer or secondary QLLC link station in the adjacent node. The information field of the TEST command/response contains the test pattern data.

Upon receipt of a TEST command QLLU, peer and secondary QLLC link stations transfer the corresponding TEST response QLLU with the information field containing the test pattern data received in the QTEST command.

O.2.5.8 Q_Unnumbered_Acknowledgment (QUA)

The Unnumbered_Acknowledgment response QLLU is transferred by peer and secondary QLLC link stations in response to QSM or QDISC commands. No information field is permitted with the QUA response.

Upon receipt of the QUA response across a link connection perceived by a peer or primary QLLC link station to be in the OPENING state, the receiving peer or primary QLLC link station places that link connection in the OPENED state. Upon receipt of the QUA response across a link connection perceived by a peer or primary QLLC link station to be in the CLOSING state, the receiving peer or primary QLLC link station places that link connection in the CLOSED state.

O.2.5.9 Q_XID_Command and Q_XID_Response (QXID)

The Exchange_Identification command QLLU may be issued by peer and primary QLLC link stations to solicit identification information from the peer or secondary communicating link station in the adjacent node. The information field of the QXID command/response contains the transmitting link station's identification information.

Upon receipt of an XID command QLLU, peer and secondary QLLC link stations transfer the corresponding XID response QLLU as soon as the identification information is available.

O.2.6 Function descriptions

The following are descriptions of some of the functions specified by the QLLC finite state machine; see "Description of the Procedure" on page O-14. Other functions are self-explanatory.

O.2.6.1 Increment Counter

Increment the retransmission count. If the transmission limit has been exceeded, notify a higher layer and wait for further directions.

O.2.6.2 Inform Higher Layer

Notify the higher layer of a particular occurrence and request help from the higher layer in formulating an appropriate answer.

O.2.6.3 Ignore Logical Link Unit

Discard the data logical link unit (DLLU) or the qualified logical link unit (QLLU) just received from the packet layer.

O.2.6.4 Local Error

Either ignore or report to a higher layer the internal signalling error or illogical protocol sequence on the part of an entity at the local link station.

O.2.6.5 Remote Error

Either ignore or report to a higher layer the protocol procedure error on the part of the QLLC link station in the adjacent node.

O.2.6.6 Report Status

Notify the higher layer that the QLLC link station has received a request from the remote station and may have responded to the information. Report status may also be used to notify the higher layer that the local link station has changed states.

O.3 Description of the Procedure

A finite state machine is a graphical device that can be used to show how a mechanism operates. It is especially useful for illustrating the operational definitions of communication architectures. Finite state machines exist in many forms; the following describe how to read the finite state machine form used in defining the QLLC architecture. The reader must refer to the following pages, which show the QLLC finite state machine (QLLC_FSM), while reading the below example and generic description.

Example: A Reading of the QLLC Finite State Machine (QLLC_FSM)

Suppose we are in state 04, the CLOSING state, and receive an input of Packet Layer Ready. The FSM changes to state 02, the CLOSED state, and performs procedure D. Looking below the matrix, in the column OUTPUT CODE, we find the letter D. Now looking to the right of D, in the Function column, we find the procedure to be performed: Report status. After the procedure is performed the reader exits from the FSM, leaving the FSM in state 02, the CLOSED state.

Generic Description: How to Read a finite state machine (FSM)

To find the actions performed when a certain event takes place, cross-reference the appropriate input with the current state. At the intersection is an action code, which consists of a next state indicator and an output code. The next state indicator is either '-', meaning no state change takes place, or a number, which represents the new state. The output code, an alphanumeric identifier, references the output code section located directly after the matrix. Adjacent to the output codes are the functions to be performed.

When the FSM is first activated it is placed in state 01, the initial state. In the QLLC finite state machine the initial state is the inoperative (INOP) state.

Function: QLLC_FSM is a finite state machine that represents the logical link connection between adjacent SNA nodes. The machine consists of states, inputs, output codes, and functions.

The initial state of the finite state machine is the INOP state. The states are described in "Elements of Procedure" on page O-3.

There are three kinds of input: external stimuli, commands and responses, and state change events. For a description of the external stimuli see "External Stimuli" on page O-6; for commands and responses see "QLLC Commands and Responses" on page O-9. The state change events are the bottom entries in the inputs column of the FSM, each beginning with Go to.

The output codes are symbols such as, A, F, HH, and S, that are in the matrix and also in the left column below the matrix. They are simply a tag to identify which function to perform.

The functions, which are procedures to be executed, are in the right column below the matrix. Within the functions are procedural statements that describe the work to be performed by the particular function. Some procedural statements are terse and those that are not self explanatory are further defined in "Function descriptions" on page O-13.

Within the functions, the terms PEER, PRIMARY, and SECONDARY are used to show that what follows each term applies to the station if it is a peer, primary, or secondary, respectively.

References to notes are occasionally stated in the functions. The descriptions of the notes are:

Note 1 - An exchange of QLLC link station identification information is required prior to link setup. (Some DTEs require an exchange of QLLC link station identification information prior to link setup while other DTEs do not.)

Note 2 - The virtual call (switched virtual circuit) supporting the link connection is cleared by a packet layer CLEAR_REQUEST or CLEAR_INDICATION; the underlying virtual circuit is terminated; and the QLLC link connection is placed in the inoperative (INOP) state. Notice that this comment is only true for SVCs and is not true for PVCs.

Inputs	States					
	inop	closed	opening	closing	recovery	opened
	1	2	3	4	5	6
Packet_Layer_Ready	2(A)	-(B)	2(B1)	2(D)	2(D)	2(D)
Link_Start	-(B)	-(C)	-(W)	-(B)	3(XX)	-(B)
Link_Stop	-(B)	-(B)	-(X)	-(B)	4(YY)	-(PP1)
Packet_Layer_Inoperative	-(B)	1(D)	1(D)	1(D)	1(D)	1(D)
Erroneous_QLLU	-(B)	-(E)	-(E)	-(MM)	-(AA1)	-(RR1)
Exchange_Identification	-(B)	-(F)	-(F1)	-(F2)	-(GG1)	-(F3)
Link_Test	-(B)	-(G)	-(G1)	-(G2)	-(HH1)	-(G3)
Send_Data	-(B)	-(B)	-(B)	-(B)	-(B)	-(SS1)
Virtual_Circuit_Clear_Reset	-(B)	-(B2)	-(AA)	-(D5)	-(D5)	-(D5)
Link_Timeout_Expiration	-(B)	-(OO)	-(OO)	-(OO)	-(OO)	-(OO)
Receive_Data	-(B)	-(J)	-(CC)	-(PP)	-(H)	-(UU1)
Q_Receive_Ready	-(B)	-(K)	-(DD)	-(K)	-(FF1)	-(K)
Q_Set_Mode	-(B)	-(L)	-(EE)	-(QQ)	2(DD1)	-(VV1)
Q_Disconnect	-(B)	-(L1)	-(FF)	2(RR)	2(EE1)	2(WW1)
Q_Unnumbered_Acknowledgement	-(B)	-(N)	-(GG)	-(SS)	-(FF1)	-(XX1)
Q_Request_Disconnect	-(B)	-(O)	-(HH)	-(TT)	-(FF1)	-(YY1)
Q_Disconnected_Mode	-(B)	-(P)	-(II)	-(UU)	-(FF1)	-(AA2)
Q_Frame_Reject	-(B)	-(Q)	-(JJ)	-(VV)	-(FF2)	-(AA2)
Q_XID_Command	-(B)	-(R)	-(R2)	-(R4)	-(JJ1)	-(R6)
Q_XID_Response	-(B)	-(S)	-(S2)	-(S4)	-(KK1)	-(S6)
Q_Test_Command	-(B)	-(R1)	-(R3)	-(R5)	-(JJ1)	-(R7)
Q_Test_Response	-(B)	-(S1)	-(S3)	-(S5)	-(KK1)	-(S7)
Go_to_INOP_state	-	1	1	1	1	1
Go_to_CLOSED_state	2	-	2	2	2	2
Go_to_OPENING_state	3	3	-	3	3	3
Go_to_CLOSING_state	4	4	4	-	4	4
Go_to_RECOVERY_state	5	5	5	5	-	5
Go_to_OPENED_state	6	6	6	6	6	-

Output Code	Function
A	Logical link is now operational. Set predicate condition to NULL

Output Code	Function

AA	PEER & PRIMARY
	If the virtual circuit is a PVC then
	If predicate condition is NULL then
	Set predicate condition to RRp
	OR: Pass the cause and diagnostic information to higher layer
	Go to CLOSED state
	Else Set predicate condition to NULL
	Transfer Q_Set_Mode to the remote logical link station
	Else Pass the cause and diagnostic information to higher layer
	Go to the inoperative (INOP) state
	
	SECONDARY
	Pass the cause and diagnostic information to higher layer
	If the virtual circuit is a PVC then
	Set predicate condition to NULL
	Go to CLOSED state
	Else go to inoperative (INOP) state

AA1	PEER Remote Error OR: Report Status Transfer Q_Frame_Reject PRIMARY (Primary does not have a RECOVERY state.) SECONDARY Remote Error Transfer Q_Frame_Reject OR: Report Status Transfer Q_Frame_Reject Go to CLOSED state
AA2	PEER & PRIMARY Report Status Set predicate condition to NULL Request Packet Layer to clear SVC or reset PVC Go to CLOSED state SECONDARY Report Status Transfer Q_Frame_Reject Go to RECOVERY state
B	PEER, PRIMARY, & SECONDARY Local Error (Primary does not have a RECOVERY state.)

Output Code	Function
B1	PEER, PRIMARY, & SECONDARY Report Status Set predicate condition to NULL
B2	PEER, PRIMARY, & SECONDARY Pass the cause and diagnostic information to higher layer If the virtual circuit is a PVC then Set predicate condition to NULL Else go to inoperative (INOP) state
C	PEER & PRIMARY Set predicate condition to NULL Transfer Q_Set_Mode Go to OPENING state OR: (See note 1) If predicate condition is SMp then Transfer Q_Set_Mode Set predicate condition to NULL Go to OPENING state Else Local Error SECONDARY Secondary is now in a condition to accept a Q_Set_Mode_Command. Go to OPENING state
CC	PEER & PRIMARY Remote Error SECONDARY If predicate condition is CTp then Report Status Set predicate condition to NULL Go to OPENED state Else Report Status Ignore Logical Link Unit OR: Remote Error
D	PEER, PRIMARY, & SECONDARY Report Status (Primary does not have a RECOVERY state.)

DD	PEER & PRIMARY
	Ignore Logical Link Unit
	
	SECONDARY
	If predicate condition is CTp then
	Report Status
	Set predicate condition to NULL
	Go to OPENED state
	Else
	Ignore Logical Link Unit

Output Code	Function
D5	PEER, PRIMARY, & SECONDARY Pass cause and diagnostic information to higher layer If the virtual circuit is a PVC then Set predicate condition to NULL Go to CLOSED state Else go to inoperative (INOP) state
DD1	PEER & SECONDARY Report Status Set predicate condition to NULL Transfer Q_Disconnected_Mode PRIMARY (Primary does not have a RECOVERY state.)
E	PEER, PRIMARY, & SECONDARY Remote Error

EE	PEER
	If predicate condition is OXRp or OTRp then
	Report Status
	Set predicate condition to NULL
	Request Packet Layer to clear SVC or reset PVC
	Go to CLOSED state
	Else Transfer Q_Unnumbered_Acknowledgement
	OR: (See note 1)
	If predicate condition is SMp then
	Transfer Q_Set_Mode
	Set predicate condition to NULL
	Go to OPENING state
	Else Local Error
	
	PRIMARY
	Remote Error
	
	SECONDARY
	If predicate condition is OXRp or OTRp then
	Report Status
	Set predicate condition to NULL
	Request Packet Layer to clear SVC or reset PVC
	Go to CLOSED state
	Else Report Status
	Transfer Q_Unnumbered_Ack
	Go to OPENED State
	OR: Set predicate condition to CTp
	Transfer Q_Unnumbered_Ack

Output Code	Function
EE1	PEER & SECONDARY Report Status Set predicate condition to NULL Transfer Q_Unnumbered_Acknowledgement PRIMARY (Primary does not have a RECOVERY state.)

F	PEER
	When predicate condition is :
	NULL - Set predicate condition to IXRp
	Transfer Q_XID_Command
	OXRp - Set predicate condition to SMp
	Transfer Q_XID_Response
	IOXRp - Set predicate condition to IXRp
	Transfer Q_XID_Response
	OTRp - Set predicate condition to IXOTRp
	Transfer Q_XID_Command
	SMp - Set predicate condition to IXRp
	Transfer Q_XID_Command
	Otherwise - Local Error
	
	PRIMARY
	If predicate condition is IXRp or ITRp then
	Local Error
	Else Set predicate condition to IXRp
	Transfer Q_XID_Command
	
	SECONDARY
	If predicate condition is OXRp then
	Set predicate condition to NULL
	Transfer Q_XID_Response
	Else Local Error

Output Code	Function

FF	PEER
	 Report Status
	 If predicate condition is OXRp or OTRp then
	   Set predicate condition to NULL
	   Request Packet Layer to clear SVC or reset PVC
	   Go to CLOSED state
	 Else Transfer Q_Disconnected_Mode
	    Set predicate condition to NULL
	    Go to CLOSED state
	
	PRIMARY
	 Remote Error
	
	SECONDARY
	 Report Status
	 Transfer Q_Disconnected_Mode
	 Go to CLOSED state

F1	PEER
	 If predicate condition is OXRp, ITOXRp, or IOXRp then
	   Set predicate condition to NULL
	   Transfer Q_XID_Response
	 Else Local Error
	
	PRIMARY
	 Local Error
	
	SECONDARY
	 If predicate condition is OXRp then
	   Set predicate condition to NULL
	   Transfer Q_XID_Response
	 Else Local Error

F2	PEER & SECONDARY
	 If predicate condition is OXRp then
	   Set predicate condition to NULL
	   Transfer Q_XID_Response
	 Else Local Error
	
	PRIMARY
	 Local Error

Output Code	Function

F3	PEER
	When predicate condition is :
	NULL - Set predicate condition to IXRp
	Transfer Q_XID_Command
	OXRp - Set predicate condition to NULL
	Transfer Q_XID_Response
	OTRp - Set predicate condition to IXOTRp
	Transfer Q_XID_Command
	ITOXRp - Set predicate condition to ITRp
	Transfer Q_XID_Response
	Otherwise - Local Error
	
	PRIMARY
	If predicate condition is IXRp or ITRp then
	Local Error
	Else Transfer Q_XID_Command
	Set predicate condition to IXRp
	
	SECONDARY
	If predicate condition is OXRp then
	Set predicate condition to NULL
	Transfer Q_XID_Response
	Else Local Error

FF1	PEER & SECONDARY Remote Error Transfer Q_Frame_Reject PRIMARY (Primary does not have a RECOVERY state.)
FF2	PEER Inform Higher Layer Set predicate condition to NULL Go to CLOSED state PRIMARY (Primary does not have a RECOVERY state.) SECONDARY Remote Error Transfer Q_Frame_Reject

Output Code	Function

G	PEER
	When predicate condition is :
	NULL - Set predicate condition to ITRp
	Transfer Q_TEST_Command
	OXRp - Set predicate condition to ITOXRp
	Transfer Q_TEST_Command
	OTRp - Set predicate condition to NULL
	Transfer Q_TEST_Response
	IOTRp - Set predicate condition to ITRp
	Transfer Q_TEST_Response
	IXOTRp - Set predicate condition to IXRp
	Transfer Q_TEST_Response
	SMp - Set predicate condition to ITRp
	Transfer Q_TEST_Command
	Otherwise - Local Error
	
	PRIMARY
	If predicate condition is IXRp or ITRp then
	Local Error
	Else set predicate condition to ITRp
	Transfer Q_TEST_Command
	
	SECONDARY
	If predicate conditon is OTRp then
	Set predicate condition to NULL
	Transfer Q_TEST_Response
	Else Local Error

GG	PEER Report Status Go to OPENED state PRIMARY Report Status Go to OPENED state OR Report Status Transfer Q_Receive_Ready Go to OPENED state SECONDARY Remote Error
G1	PEER & SECONDARY If predicate condition is OTRp, IOTRp, or IXOTRp then Set predicate condition to NULL Transfer Q_TEST_Response Else Local Error PRIMARY Local Error

Output Code	Function
G2	PEER & SECONDARY If predicate condition is OTRp then Set predicate condition to NULL Transfer Q_Test_Response Else Local Error PRIMARY Local Error

G3	PEER
	When predicate condition is :
	NULL - Set predicate condition to ITRp
	Transfer Q_TEST_Command
	OXRp - Set predicate condition to ITOXRp
	Transfer Q_TEST_Command
	OTRp - Set predicate condition to NULL
	Transfer Q_TEST_Response
	IXOTRp - Set predicate condition to IXRp
	Transfer Q_TEST_Response
	Otherwise - Local Error
	
	PRIMARY
	If predicate condition is IXRp or ITRp then
	Local Error
	Else Transfer Q_TEST_Command
	Set predicate condition to ITRp
	
	SECONDARY
	If predicate condition is OTRp then
	Set predicate condition to NULL
	Transfer Q_TEST_Response
	Else Local Error

GG1	PEER & SECONDARY Local Error PRIMARY (Primary does not have a RECOVERY state.)
H	PEER Remote Error PRIMARY (Primary does not have a RECOVERY state.) SECONDARY Ignore Logical Link Unit

Output Code	Function
HH	PEER & SECONDARY + Remote Error PRIMARY Inform Higher Layer
HH1	PEER & SECONDARY Local Error PRIMARY (Primary does not have a RECOVERY state.)
II	PEER & PRIMARY Report Status Set predicate condition to NULL Go to CLOSED state SECONDARY + Remote Error
J	PEER, PRIMARY, & SECONDARY Remote Error
JJ	PEER & PRIMARY inform Higher Layer SECONDARY + Remote Error
JJ1	PEER & SECONDARY Remote Error Transfer Q_Frame_Reject PRIMARY (Primary does not have a RECOVERY state.)
K	Ignore Logical Link Unit (Primary does not have a RECOVERY state.)
KK1	PEER & SECONDARY Remote Error Transfer Q_Frame_Reject PRIMARY (Primary does not have a RECOVERY state.)

Output Code	Function

L	PEER
	If predicate condition is NULL then
	Report Status
	Transfer Q_Disconnected_Mode
	Else
	If predicate condition is SMp then
	Inform Higher Layer
	Else Remote Error
	
	PRIMARY
	Remote Error
	
	SECONDARY
	If predicate condition is OXRp or OTRp then
	Remote error
	Set predicate condition to NULL
	Request Packet Layer to clear SVC or reset PVC
	Else transfer Q_Disconnected_Mode

L1	PEER
	If predicate condition is NULL or SMp then
	Report Status
	Transfer Q_Disconnected_Mode
	Else
	Remote Error
	
	PRIMARY
	Remote Error
	
	SECONDARY
	Set predicate condition to NULL
	Transfer Q_Disconnected_Mode

MM	PEER & PRIMARY Remote Error SECONDARY Report Status Transfer Q_Frame_Reject Go to RECOVERY state OR: Report Status Transfer Q_Frame_Reject Go to CLOSED state

N	PEER
	If predicate condition is NULL then
	Ignore Logical Link Unit
	Else
	Remote Error
	
	PRIMARY & SECONDARY
	Remote Error

Output Code	Function
O	PEER & SECONDARY Remote Error PRIMARY Remote Error Transfer Q_Disconnect
OO	PEER, PRIMARY, & SECONDARY Timeout processing is handled as in SDLC

P	PEER
	If predicate condition is NULL then
	Ignore Logical Link Unit
	Else
	Remote Error
	
	PRIMARY
	Ignore Logical Link Unit
	Set predicate condition to NULL
	
	SECONDARY
	Remote Error

PP	PEER, PRIMARY, & SECONDARY Pass BTU to higher layer
PP1	PEER & PRIMARY If predicate condition is IXRp or ITRp then Local Error Else Report Status Transfer Q_Disconnect Go to CLOSING state SECONDARY Report Status Transfer Q_Request_Disconnect Go to CLOSING state
Q	PEER & PRIMARY Inform Higher Layer SECONDARY Remote Error

Output Code	Function
QQ	PEER Report Status Transfer Q_Disconnected_Mode Go to CLOSED state PRIMARY Report Status Request Packet Layer to clear SVC or reset PVC Go to CLOSED state SECONDARY Report Status Transfer Q_Request_Disconnect OR: Transfer Q_Request_Disconnect

R	PEER
	When predicate condition is :
	NULL Set predicate condition to OXRp
	Pass XID information to higher layer
	IXRp - Set predicate condition to IOXRp
	Pass XID information to higher layer
	SMp - Set predicate condition to OXRp
	Pass XID information to higher layer
	Otherwise - Remote Error
	
	PRIMARY
	Pass XID data to higher layer
	OR: Remote Error
	
	SECONDARY
	If predicate condition is OTRp then
	Remote Error
	OR: Ignore Logical Link Unit
	Else
	Pass XID data to higher layer
	Set predicate condition to OXRp

RR	PEER & SECONDARY Report Status Set predicate condition to NULL Transfer Q_Unnumbered_Acknowledgement PRIMARY Report Status Request Packet Layer to clear SVC or reset PVC

Output Code	Function

R1	PEER
	When predicate condition is :
	NULL - Pass test data to higher layer
	Set predicate condition to OTRp
	ITRp - Pass test data to higher layer
	Set predicate condition to IOTRp
	SMp - Pass test data to higher layer
	Set predicate condition to OTRp
	IXRp - Pass test data to higher layer
	Set predicate condition to IXOTRp
	Otherwise - Remote Error
	
	PRIMARY
	Pass test data to higher layer
	OR: Remote Error
	
	SECONDARY
	If predicate condition is OXRp then
	Remote Error
	OR: Ignore Logical Link Unit
	Else
	Set predicate condition to OTRp
	Pass test data to higher layer
	OR: Transfer Q_Test_Response

R2	PEER If predicate condition is OXRp or OTRp then Report Status Set predicate condition to NULL Request Packet Layer to clear SVC or reset PVC Go to CLOSED state Else Ignore Logical Link Unit PRIMARY Remote error SECONDARY Inform Higher Layer Set predicate condition to OXRp
R3	PEER & SECONDARY Pass test data to higher layer Set predicate condition to OTRp OR: Remote Error PRIMARY Remote error

Output Code	Function
R4	PEER Report Status Transfer Q_Disconnected_Mode Set predicate condition to NULL Go to CLOSED state PRIMARY Remote error SECONDARY Pass XID data to higher layer Set predicate condition to OXRp
R5	PEER Report Status Transfer Q_Disconnected_Mode Set predicate condition to NULL Go to CLOSED state PRIMARY Remote error SECONDARY Pass test data to higher layer Set predicate condition to OTRp OR: Transfer Q_Test_Response

Output Code	Function
R6	PEER When predicate condition is : NULL - Set predicate condition to OXRp Pass XID data to higher layer IXRp - Set predicate condition IOXRp Pass XID data to higher layer OXRp - Report Status Set predicate condition to NULL Go to CLOSED state IOXRp - Report Status Set predicate condition to NULL Go to CLOSED state ITRp - Pass XID data to higher layer Set predicate condition to ITOXRp Otherwise - Report Status Set predicate condition to NULL Request Packet Layer to clear SVC or reset PVC Go to CLOSED state PRIMARY Set predicate condition to NULL Pass XID data to higher layer SECONDARY If predicate condition is OTRp then Report Status Set predicate condition to NULL Transfer Q_Disconnected_Mode Go to CLOSED state Else Inform Higher Layer Set predicate condition to OXRp

Output Code	Function

R7	PEER
	When predicate condition is :
	NULL - Set predicate condition to OTRp
	Pass test data to higher layer
	IXRp - Set predicate condition to IXOTRp
	Pass test data to higher layer
	ITRp - Set predicate condition to IOTRp
	Pass test data to higher layer
	Otherwise - Report Status
	Set predicate condition to NULL
	Request Packet Layer to clear SVC or reset PVC
	Go to CLOSED state
	OR: Transfer Q_Test_Response
	
	PRIMARY
	If predicate condition is ITRp then
	Set predicate condition to NULL
	Pass test data to higher layer
	Else Report Status
	Set predicate condition to NULL
	Request Packet Layer to clear SVC or reset PVC
	Go to CLOSED state
	
	SECONDARY
	If predicate condition is OXRp then
	Report Status
	Set predicate condition to NULL
	Transfer Q_Disconnected_Mode
	Go to CLOSED state
	Else set predicate condition to OTRp
	Pass test data to higher layer
	OR: Report Status
	Transfer Q_Test_Response

Output Code	Function
RR1	PEER Report Status Transfer Q_Frame_Reject Go to RECOVERY State PRIMARY Report Status Request Packet Layer to clear SVC or reset PVC Go to CLOSED state SECONDARY Report Status Transfer Q_Frame_Reject Go to RECOVERY state OR: Report Status Transfer Q_Frame_Reject Set predicate condition to NULL Go to CLOSED state

S	PEER
	When predicate condition is :
	IXRp - Pass XID data to higher layer
	Set predicate condition to SMp
	IOXRp - Pass XID data to higher layer
	Set predicate condition to OXRp
	IXOTRp - Pass XID data to higher layer
	Set predicate condition to OTRp
	Otherwise - Remote Error
	
	PRIMARY
	If predicate condition is IXRp then
	Set predicate condition to SMp
	Pass XID data to higher layer
	Else
	Pass XID data to higher layer
	
	SECONDARY
	Remote Error

SS	PEER & PRIMARY Report Status Set predicate condition to NULL Go to CLOSED state SECONDARY Report Status Transfer Q_Frame_Reject Go to RECOVERY state

Output Code	Function

s1	PEER
	When predicate condition is :
	ITRp - Pass test data to higher layer
	Set predicate condition to NULL
	IOTRp - Pass test data to higher layer
	Set predicate condition to OTRp
	ITOXRp - Pass test data to higher layer
	Set predicate condition to OXRp
	Otherwise - Remote Error
	
	PRIMARY
	If predicate condition is ITRp then
	Pass test data to higher layer
	Set predicate condition to NULL
	Else
	Remote Error
	
	SECONDARY
	Remote Error

s2	PEER If predicate condition is IXRp then Pass XID data to higher layer Set predicate condition to NULL Else Remote Error PRIMARY Remote error SECONDARY Remote Error
S3	PEER If predicate condition is ITRp then Pass test data to higher layer Set predicate condition to NULL Else Remote Error PRIMARY Remote error SECONDARY Remote Error
S4	PEER Ignore Logical Link Unit PRIMARY Remote Error SECONDARY Remote Error

Output Code	Function
S5	PEER Ignore Logical Link Unit PRIMARY Remote error SECONDARY Remote Error
s6	PEER When predicate condition is : IXRp - Set predicate condition to NULL Pass XID data to higher layer IOXRp - Set predicate condition to OXRp Pass XID data to higher layer IXOTRp - Set predicate condition to OTRp Pass XID data to higher layer Otherwise - Report Status Set predicate condition to NULL Request Packet Layer to clear SVC or reset PVC Go to CLOSED state PRIMARY If predicate condition is IXRp then Set predicate condition to NULL Pass XID data to higher layer Else Report Status Set predicate condition to NULL Request Packet Layer to clear SVC or reset PVC Go to CLOSED state SECONDARY Remote Error

Output Code	Function
s7	PEER When predicate condition is : ITRp - Set predicate condition to NULL Pass test data to higher layer ITOXRp - Set predicate condition to OXRp Pass test data to higher layer IOTRp - Set predicate condition to OTRp Pass test data to higher layer Otherwise - Report Status Set predicate condition to NULL Request Packet Layer to clear SVC or reset PVC Go to CLOSED state PRIMARY If predicate condition is ITRp then Set predicate condition to NULL Pass test data to higher layer Else Report Status Set predicate condition to NULL Request Packet Layer to clear SVC or reset PVC Go to CLOSED state SECONDARY + Remote Error
SS1	PEER, PRIMARY, & SECONDARY Transfer Data Logical Link Unit
+ TT	PEER + Remote Error PRIMARY Report Status OR: Ignore Logical Link Unit + SECONDARY + Report Status + Transfer Q_Frame_Reject + Go to RECOVERY state
UU	PEER & PRIMARY + Set predicate condition to NULL Report Status Go to CLOSED state SECONDARY Report Status Transfer Q_Frame_Reject Go to RECOVERY state
UU1	PEER, PRIMARY, & SECONDARY Pass BTU to higher layer

Output Code	Function
VV	PEER Ignore Logical Link Unit PRIMARY Report Status Request Packet Layer to clear SVC or reset PVC Go to CLOSED state SECONDARY Report Status Transfer Q_Frame_Reject Go to RECOVERY state
VV1	PEER & SECONDARY Report Status Transfer Q_Disconnected_Mode Set predicate condition to NULL Go to CLOSED state PRIMARY Report Status Request packet layer to clear SVC or reset PVC Set predicate condition to NULL Go to CLOSED state
W	PEER If Predicate condition is RRp then Report Status Else Local Error PRIMARY Local Error SECONDARY Local Error
WW1	PEER & SECONDARY Report Status Transfer Q_Unnumbered_Acknowledgement Set predicate condition to NULL Go to CLOSED state PRIMARY Report Status Set predicate condition to NULL Request Packet Layer to clear SVC or reset PVC Go to CLOSED state

Output Code	Function
X	PEER & PRIMARY Local Error SECONDARY Report Status Set predicate condition to NULL Go to CLOSED state
XX	PEER Transfer Q_Set_Mode PRIMARY (Primary does not have a RECOVERY state.) SECONDARY Set predicate condition to NULL
XX1	PEER & PRIMARY Remote Error SECONDARY Report Status Transfer Q_Frame_Reject Go to RECOVERY state
YY	PEER Transfer Q_Disconnect PRIMARY (Primary does not have a RECOVERY state.) SECONDARY Transfer Q_Request_Disconnect
YY1	PEER & SECONDARY Report Status Transfer Q_Frame_Reject Go to RECOVERY state PRIMARY Report Status Transfer Q_Disconnect Go to CLOSING state

Appendix V. Addresses in Call Set-up and Clearing Packets

V.1 Main address and complementary address

A DTE address may include two components: a main address and a complementary address.

V.1.1 Main address

When the A bit is set to '0', the main address is conforming to formats described in CCITT Recommendation X.121 and X.301 (including possible prefixes and/or escape codes).

When the A bit is set to '1', the main address is as described below.

Type of address	Numbering plan identification	Address digits

|←1 semi-octet→|←1 semi-octet→|

Format of the main address when the A bit is set to '1'

The possible values and the semantic of these subfields are described in section 5.2.1.2.

V.1.2 Complementary address

A complementary address is address information additional to that defined in CCITT Recommendation X.121 (see section 6.8.1 of CCITT Recommendation X.301).

Some networks allow the DTE to include a complementary address. When a complementary address is permitted by the network, the DTE is not obliged to use this complementary address. The complementary address may be as long as possible in considering the maximum value of the DTE address length fields defined in sections 5.2.1.1 and 5.2.1.2.

When a complementary address is contained in a DTE address field of a packet transmitted by the network to the DTE, this complementary address is always passed transparently from the remote DTE: it means that the network never creates a complementary address from itself.

When a complementary address is invoked in the following sections, it is supposed that the network supports the use of complementary address.

When the A bit is set to '1' and a complementary address is present alone (i. e., without main address) in a DTE address field, it is preceded by the type of address and numbering plan identification subfields.

V.2 Address in CALL_REQUEST packet

In CALL_REQUEST packet, the called DTE address should be provided by the DTE except when the Bilateral_Closed_User_Group_Selection is provided in the facility field (see section 6.15.3). Depending on the called network and the DTE, this called DTE address may be made of a main address then a complementary address, or of a main address alone.

Depending on the network, the DTE may have the following possibilities for the calling DTE address:

- The DTE may include either no calling DTE address, or a main address optionally followed by a complementary address. When a calling DTE address is provided by the DTE, the network is required to check its validity. If the calling DTE address is not valid, the network may either replace this invalid calling DTE address by a valid one, or clear the call. If the Hunt_Group facility has been subscribed to by the calling DTE (see section 6.24) and a specific address has been assigned to the calling DTE/DCE interface, the main address provided by the calling DTE may be the hunt group address or the specific address.

  Note:

  In this later case, some networks do not allow the calling DTE to indicate the hunt group address, but only the specific address.

- The DTE may include either no calling DTE address, or a calling complementary address. In this last case, when the A bit is set to '1', this complementary address shall be preceded by the type of address and numbering plan identification subfields.

V.3 Address in INCOMING_CALL packets

In INCOMING_CALL packet, the calling DTE address should be provided by the DCE except when the Bilateral_Closed_User_Group_Selection is provided in the facility field (see section 6.15.3) or in one case described in section 6.28. This calling DTE address always includes a main address. This main address is followed by a calling complementary address if such a complementary address had been provided by the calling DTE in the CALL_REQUEST packet, and the calling DTE address was considered as valid by the network at the calling DTE side. If the Hunt_Group facility has been subscribed to by the calling DTE (see section 6.24) and a specific address has been assigned to the calling DTE/DCE interface, the main address indicated in the calling DTE address field may be the hunt group address (only if the calling DTE had indicated either its hunt group address or no main address, in the calling DTE address field of the CALL_REQUEST packet) or the specific address (regardless of the contents of the calling DTE address field in the CALL_REQUEST packet).

Depending on the network, the called DTE address may be made of:

- The main called address optionally followed by the called complementary address if this complementary address had been provided by the calling DTE. If the Hunt_Group facility has been subscribed to by the called DTE (see section 6.24) and a specific address has been assigned to the called DTE/DCE interface, the main address indicated in the called DTE address field may be the hunt group address (only if the calling DTE had indicated this hunt group address or no main address, in the calling DTE address field of the CALL_REQUEST packet) or the specific address (regardless of the contents of the calling DTE address field in the CALL_REQUEST packet).

- The called complementary address alone when provided by the calling DTE, or nothing if the calling DTE had not provided this called complementary address. When a called complementary address is alone and the A bit is set to '1', the called complementary address is preceded by the type of address and numbering plan identification subfields.

V.4 Address in CALL_ACCEPTED packets

Some networks do not allow any DTE addresses in CALL_ACCEPTED packets except a called DTE address in conjunction with the Called_Line_Address_Modified_Notification facility when supported by the network and provided by the DTE.

Some other networks allow the DTE to include in the CALL_ACCEPTED packet none, one or both of the two DTE addresses. When provided by the DTE, the calling DTE address in the CALL_ACCEPTED packet should be the same as the calling DTE address in the INCOMING_CALL packet. When provided by the DTE, the called DTE address in the CALL_ACCEPTED packet should be the same as the called DTE address in the INCOMING_CALL packet, except if the Called_Line_Address_Modified_Notification facility (when supported by the network) is also provided by the DTE.

When the Called_Line_Address_Modified_Notification facility (when supported by the network) is provided by the DTE in the CALL_ACCEPTED packet, the called DTE address may be made of one of the following exclusive network dependent possibilities:

- A main DTE address identical to that of the INCOMING_CALL packet, followed by a called complementary address different from that of the INCOMING_CALL packet, or another main DTE address valid for the DTE/DCE interface optionally followed by any complementary address.
- A called complementary address, different from that which was possibly present in the called DTE address of the INCOMING_CALL packet. In this case, when the A bit is set to '1', the called complementary address shall be preceded by the type of address and numbering plan identification subfields.

V.5 Address in CALL_CONNECTED packets

Some networks do not provide any DTE address in CALL_CONNECTED packets except a called DTE address in conjunction with the Called_Line_Address_Modified_Notification facility.

Some networks always provide both DTE addresses in CALL_CONNECTED packets.

Some other networks provide a DTE address in a CALL_CONNECTED packet only if this DTE address was present in the CALL_ACCEPTED packet or in conjunction with the Called_Line_Address_Modified_Notification facility.

In any case, when an address is provided by the network in the CALL_CONNECTED packet, this address should be the same as that in the CALL_REQUEST packet except when the Called_Line_Address_Modified_Notification facility is present in the facility field: in this case, the called DTE address always contains a main address optionally followed by a complementary address.

V.6 Address in CLEAR_REQUEST packets

No address is permitted in CLEAR_REQUEST packets except a called DTE address when the Called_Line_Address_Modified_Notification facility (see section 6.26) is used in this packet. In this case, the CLEAR_REQUEST packet is transmitted as a direct response to the INCOMING_CALL packet and the called DTE address may be made of one of the following network dependent possibilities:

- A main DTE address identical to that of the INCOMING_CALL packet, followed by a called complementary address different from that of the INCOMING_CALL packet, or another main DTE address valid for the DTE/DCE interface.
- A called complementary address, different from that which was possibly present in the called DTE address of the INCOMING_CALL packet. In this case, when the A bit is set to '1', the called complementary address shall be preceded by the type of address and numbering plan identification subfields.

V.7 Address in CLEAR_INDICATION packets

No address is permitted in CLEAR_INDICATION packets except when the Called_Line_Address_Modified_Notification facility (see section 6.26) is used in this packet. In this case, the CLEAR_INDICATION packet is transmitted as a direct response to the CALL_REQUEST packet and the called DTE address always contains a main address optionally followed by a complementary address.

V.8 Address in CLEAR_CONFIRMATION packets

DTE addresses are not present in CLEAR_CONFIRMATION packets.

V.9 Addresses in Call_Redirection and Call_Deflection facilities

The alternative DTE address, indicated at subscription-time (for the Call_Redirection facility) or in the Call_Deflection_Selection facility of the CLEAR_REQUEST packet (see sections 6.25.1 and 6.25.2), is composed of a main address optionally followed by a complementary address.

If a called complementary address was present in the CALL_REQUEST packet, some networks may add this called complementary address after the alternative DTE address.

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Reader's Comments

The X.25 1984/1988 DTE/DCE and DTE/DTE Interface Architecture Reference

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