IBM

X.25 SNA Interconnection
Program Numbers 5685-005 and 5685-035

GH19-6576-0

Data Terminal Equipment/ Data Circuit-Terminating Equipment Interface Description

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Data Terminal Equipment/ Data Circuit-Terminating Equipment Interface Description

X.25 SNA Intercorrection:

Version 1, Program Number 5685-005, Releases 1 and 2

Version 2, Program Number 5685-035

X.25 SNA Network Supervisory Function:

Program Number 5685-003, Releases 1 and 2

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This edition applies to the following IBM Licensed Programs, and to all subsequent releases and modifications until otherwise indicated in new editions or Technical Newsletters:

- X.25 SNA Interconnection:
  - Version 1, Program Number 5685-005, Releases 1 and 2
  - Version 2, Program Number 5685-035
- X.25 SNA Network Supervisory Function:
  - Program Number 5685-003, Releases 1 and 2

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This manual describes the interface that a network based on the IBM X.25 SNA Interconnection Licensed Program (abbreviated as XI in this manual) provides for attachment of X.25 Data Terminal Equipments (DTEs). The manual is intended for network service providers.

DTEs can be attached to an IBM 3725, 3720 or 3745 Communication Controller running (at least) the Network Control Program (NCP) and the IBM X.25 SNA Interconnection Licensed Program. Such an assembly of hardware (Communication Controller) and software (NCP and XI) is called an XI node.

XI offers attachment through leased circuits or switched circuits. For leased attachment, the interface is based on the CCITT Recommendation X.25. For switched attachment, the interface is based on the CCITT Recommendation X.32.

Correspondence with CCITT Recommendation X.25

The DTE interface provided by XI is based on the 1984 version of CCITT Recommendation X.25, but maintains compatibility with the 1980 version.

Notes:

- In this part, portions of CCITT Recommendation X.25 (Malaga-Torremolinos, October 1984) from the CCITT VIIIth Plenary Assembly Red Book, Volume III - Fascicle III.3 are reproduced with special authorization of the International Telecommunications Union (ITU).
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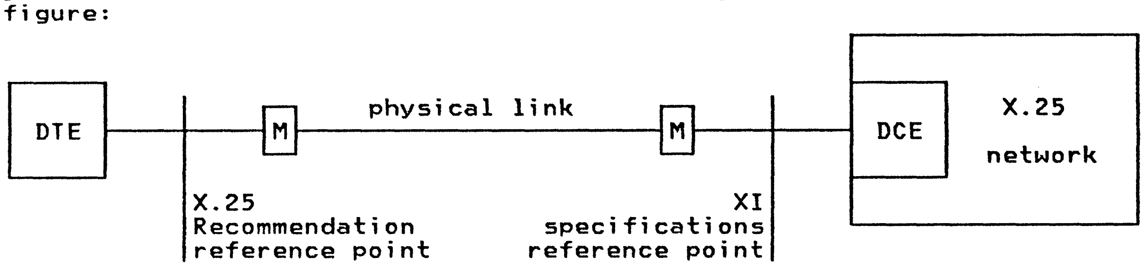
- **XI-specific text is indicated by a vertical line in the left margin.**
- Sections of the CCITT text not applicable to XI (such as additional facilities not implemented), are either omitted or marked "not applicable to XI".
- Paragraphs and sentences related to features not supported by XI have been omitted.

A major difference from Recommendation X.25 is that the XI specifications exclude the physical attachment of DTEs to the XI nodes. The XI specifications apply to the junction with the Communication Controller physical port as shown in the following figure:



Note: This example shows an access link with an analog transmission line and a pair of modems (M). The access link can also be a leased digital circuit with an X.21 interface.

XI specifications include some guidance on the monitoring of the physical link between the DTE and the DCE.

Correspondence with CCITT Recommendation X.32

The DTE interface provided by XI is based on the 1987 provisional CCITT Recommendation X.32 (Grey Book, ISBN 92-61-02911-6).

Notes:

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- XI-specific text is indicated by a vertical line in the left margin.
- Sections of the CCITT text not applicable to XI (such as additional facilities not implemented), are either omitted or marked "not applicable to XI".
- Paragraphs and sentences related to features not supported by XI have been omitted.

Overview of XI functions

Both switched virtual circuits (SVCs) and permanent virtual circuits (PVCs) are available with XI.

DTEs based on the 1984 or 1980 version of the Recommendation can be attached to an XI node and can communicate through SVCs or PVCs with DTEs based on either version 1980 or version 1984 of X.25. A summary of the differences between X.25 CCITT 1984 and 1980 is given in Annex H.

DTEs can communicate with DTEs attached to the same XI node, or to another XI node. They can also communicate with DTEs attached to a Packet Switched Data Network (PSDN) complying with Recommendation X.25, through the Gateway function of XI (referred to as GW-DTE, as it presents a DTE function to the PSDN).

DTEs can be attached to XI nodes either by leased lines or by switched lines. This manual specifies only the interface for the DTEs attached to an XI node. However, addressing conventions for communicating with DTEs attached to PSDNs are described in 5.8.

The XI Licensed Program requires the Network Supervisory Function Licensed Program (NSF) as a prerequisite program in an SNA host for management purposes.

Terms and conventions

In this manual, some CCITT terms are used that need further explanation, and some CCITT conventions are used that differ from normal IBM terms and conventions:

- For "virtual call" understand "switched virtual circuit".
- For "network" understand a collection of communicating XI nodes inside a single addressing scheme (XI network).
- For "Administration" understand "network service provider".
- For "subscription" understand the procedure defined by the network service provider to install DTE access links and set the DTE/DCE subscription parameters to consistent values.
- For "international" understand any networks that may be reached outside of the addressing scheme of the XI network, such as PSDNs connected through the gateway-DTE function or through transit PSDNs.

- For "octet" read "byte".
- The CCITT numbering of bits is used for the description of frames and packets. This numbering is different from the one normally used in IBM documentation.

Related Publications

The other publications for XI and NSF are:

XI V1R1 Licensed Program Specification, GH19-6573

XI V1R2 Licensed Program Specification, GH11-3013

XI V2 Licensed Program Specification, GH11-3024

NSF R1 Licensed Program Specification, GH19-6574

NSF R2 Licensed Program Specification, GH11-3014

XI and NSF General Information, GH19-6575.

XI and NSF Planning and Installation, GH19-6577

XI and NSF Operation, SH19-6578

XI and NSF Diagnosis Guide, LY19-6281

XI and NSF Reference Summary, LY19-6282.

PART 1: RECOMMENDATION X.25

INTERFACE BETWEEN DATA TERMINAL EQUIPMENT (DTE) AND DATA CIRCUIT TERMINATING EQUIPMENT (DCE) FOR TERMINALS OPERATING IN THE PACKET MODE AND CONNECTED TO PUBLIC DATA NETWORKS BY DEDICATED CIRCUIT

(Geneva, 1976, amended at Geneva, 1980 and Malaga-Torremolinos, 1984)

The establishment in various countries of public data networks providing packet-switched data transmission services creates a need to produce standards to facilitate international interworking.

The CCITT, considering:

(a) That Recommendation X.1 includes specific user classes of service for data terminal equipments operating in the packet mode, Recommendation X.2 defines user facilities, Recommendation X.10 defines categories of access, Recommendations X.21 and X.21 bis define DTE/DCE physical level interface characteristics, Recommendation X.92 defines the hypothetical reference connections for packet-switched data transmission service and Recommendation X.96 defines call progress signals;

(b) That data terminal equipments operating in the packet mode will send and receive network control information in the form of packets;

(c) That certain data terminal equipments operating in the packet mode will use a packet interleaved synchronous data circuit;

(d) The desirability of being able to use a single data circuit to a Data Switching Exchange (DSE) for all user facilities;

(e) That Recommendation X.2 designates virtual call and permanent virtual circuit services as essential (E) services to be provided by all networks;

(f) The need for defining an international Recommendation for the exchange between DTE and DCE of control information for the use of packet-switched data transmission services;

(g) That this definition is made in Recommendation X.32 with regard to the access through a public switched telephone network or a circuit switched public data network;

(h) That, when this Recommendation is used to provide the Network service defined in Recommendation X.213, the physical, link and packet levels correspond to the Physical, Data link and Network layers respectively, as defined in Recommendation X.200;

(i) That this Recommendation includes features which are not necessary to provide the services included in Recommendation X.213;

(j) That the necessary elements for an interface Recommendation should be defined independently as:

Physical level - the mechanical, electrical, functional and procedural characteristics to activate, maintain and deactivate the physical link between the DTE and the DCE;

Link level - the link access procedure for data interchange across the link between the DTE and the DCE;

Packet level - the the packet formats and control procedures for the exchange of packets containing control information and user data between the DTE and the DCE;

Unanimously declares the view that for data terminal equipments operating in the packet mode:

(1) The mechanical, electrical, functional and procedural characteristics to activate, maintain and deactivate the physical link between the DTE and the DCE should be as specified in 1 below, DTE/DCE interface characteristics;

(2) The link access procedure for data interchange across the link between the DTE and the DCE should be as specified in 2 below, Link access procedure across the DTE/DCE interface;

(3) The packet level procedures for the exchange of control information and user data at the DTE/DCE interface should be as specified in 3 below, Description of the packet level DTE/DCE interface;

(4) The procedures for virtual call and permanent virtual circuit services should be as specified in 4 below, Procedures for virtual circuit services;

(5) The format for packets exchanged between the DTE and the DCE should be as specified in 5 below, Packet formats;

(6) The procedures for optional user facilities should be as specified in 6 below, Procedures for optional user facilities;

(7) The formats for optional user facilities should be as specified in 7 below, Formats for facility fields and registration fields.

1. DTE/DCE INTERFACE CHARACTERISTICS (PHYSICAL LEVEL)

XI nodes offer physical interfaces compatible with V.24, V.35, and X.21 leased standards. The specifications of these interfaces are available in the documentation for the physical interfaces of the communication controllers supporting the XI node function. The line access speed can be between 2400 and 64000 bps.

The physical interface is activated/deactivated through network operator commands. With XI, it is not possible to establish test loops through network operator commands. Test loops can be manually activated (if the modem or the X.21 adaptor has the appropriate feature), but this may issue a deactivation of the physical interface if the test duration exceeds a value of 5 seconds.

In the same way, if a failure occurs on the DTE/DCE junction, which sets the physical interface to an abnormal status, transmission from the XI node can be delayed up to the same 5 seconds value before the interface is declared to be in error. If this value is exceeded, recovery procedures need to be initiated from the network operator, and if the failure cannot be repaired (e.g. access line out of order), the interface is then deactivated.

As indicated in the Preface, the following sections which describe the physical level of the DTE/DCE interface are not applicable to XI specifications. The XI reference point is the physical junction with the Communication Controller physical port, not the physical junction with the X.25 DTE. However, some indications are given when the physical attachment is with IBM modems (see Section 1.3, V-Series Interface

Administrations may offer one or more of the interfaces specified below.

1.1 X.21 INTERFACE

The X.21 Interface is supported without qualification.

1.2 X.21 BIS INTERFACE

The X.21 Bis Interface is supported without qualification.

1.3 V-SERIES INTERFACE

V-Series Interface are supported with the following qualification.

With IBM modems of the 586x family (5865 model 2 and 3, 5866 model 2 and 3, 5868 model 52 and 62), XI allows the network operator to run modem and line tests. Occurrences of such tests cause the modem adjacent to the DTE to set CCITT V.24 circuit 142 to the ON condition for the duration of the test.

During the test duration, the modem can neither transmit nor receive.

2.1 SCOPE AND FIELD OF APPLICATIONS

2.1.1

The Link Access Procedures (LAPB and LAP) are described as the Link Level Element and are used for data interchange between a DCE and DTE over a single physical circuit (LAPB and LAP), or optionally over multiple physical circuits (LAPB), operating in user classes of service 8 to 11 as indicated in Recommendation X.1.

The single link procedures (SLPs) described in 2.2, 2.3, and 2.4 (LAPB) and in 2.2, 2.6, and 2.7 (LAP) are used for data interchange over a single physical circuit, conforming to the description given in 1, between a DTE and a DCE.

2.1.2

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).

2.1.3

Each transmission facility is duplex.

2.1.4

DCE compatibility of operation with the ISO balanced classes of procedure (Class BA with options 2, 8, and Class BA with options 2, 8, 10) is achieved using the LAPB procedure described in 2.3, and 2.4 in this Recommendation. Of these classes, Class BA with options 2, 8 (LAPB modulo 8) is the basic service, and is available in all networks.

2.1.5

XI supports only the basic mode (modulo 8). SABME command cannot be used by the DTE.

2.1.6

XI offers only the LAPB procedure.

2.2 FRAME STRUCTURE

2.2.1 Introduction

All transmissions on a SLP are in frames conforming to one of the formats of Table 1/X.25 for basic (modulo 8) operation, or alternatively one of the formats of Table 2/X.25 for extended (modulo 128) operation. The flag preceding the address field is defined as the opening flag. The flag following the FCS field is defined as the closing flag.

2.2.2 Flag Sequence

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

TABLE 1/X.25

Frame formats - Basic (Modulo 8) operation

Bit order of transmission:

12345678	12345678	12345678	16 to 1	12345678
Flag	Address	Control	FCS	Flag
F	A	C	FCS	F
01111110	8-bits	8-bits	16-bits	01111110

FCS Frame Check Sequence

Bit order of transmission:

12345678	12345678	12345678		16 to 1	12345678
Flag	Address	Control	Information	FCS	Flag
F	A	C	Info	FCS	F
01111110	8-bits	8-bits	N-bits	16-bits	01111110

FCS Frame Check Sequence

Table 2/X.25(Frame formats - Extended (modulo 128) operation) is not applicable in the XI environment.

2.2.3 Address Field

The address field shall consist of one 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 (LAPB) and in 2.7.1 (LAP) below.

2.2.4 Control Field

For modulo 8 (basic) operation the control field shall consist of one octet. The content of this field is described in 2.3.2 (LAPB) and in 2.6.2 (LAP) below.

2.2.5 Information Field

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

See 2.3.4.9, 2.5.2, 2.6.4.8, and 5 for the various coding and groupings of bits in the information field as used in this Recommendation.

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

2.2.6 Transparency

The DCE, when transmitting, shall examine the frame content between the two flag sequences including the address, control, information and FCS field and shall insert a 0 bit after all sequence of 5 contiguous 1 bits (including the last 5 bits of the FCS) to ensure that a flag sequence is not simulated. The DCE or DTE, when receiving, shall examine the frame content and shall discard any 0 bit which directly follows 5 contiguous 1 bits.

2.2.7 Frame Check 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 the coefficient of the highest order term.

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

1. The remainder of xk $(x^{15} + x^{14} + x^{13} + x^{12} + x^{11} + x^{10} + x^9 + x^8 + x^7 + x^6 + x^5 + x^4 + x^3 + x^2 + x^1 + 1)$ divided (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$, where k 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.

Note - Within the first sentence, the term "xk" should be read as "x to the power of k".

As a typical implementation, at the transmitter, the initial content of the register containing the remainder of the division is preset to all 1s and is then modified by division by the generator polynomial (as described above) on the address, control and information field; the ones complement of the resulting remainder is transmitted as the 16-bits FCS.

At the receiver, the initial content of the register of the devices computing the remainder is preset to all 1s. 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 Appendix I.

2.2.8 Order of Bit Transmission

Addresses, commands, responses and sequence numbers shall be transmitted with the low order bit first (for example, the first bit of the sequence number that is transmitted shall have the weight 2^0. The order of transmitting bits within the information field is not specified under 2 of this highest term, which is found in bit position 16 of the FCS field (see Tables 1/X.25 and 2/X.25).

Note - In Tables 1/X.25 to 13/X.25, the low-order bit is defined as bit 1.

2.2.9 Invalid Frames

The definition of an invalid frame is described in 2.3.5.3 (LAPB) and in 2.6.5.3 (LAP) below.

2.2.10 Frame Abortion

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

XI does not perform frame abortion: A frame received by the DTE containing at least 7 consecutive bits set to 1 can only result from transmission errors.

2.2.11 Interface time fill

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

2.2.12 Link channel states

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

2.2.12.1 Active channel state

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

2.2.12.2 Idle channel state

The DCE incoming or outgoing channel is defined to be in an idle condition when it is receiving or transmitting, respectively, a continuous 1 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.

2.3 LAPB ELEMENTS OF PROCEDURES

2.3.1 Introduction

The LAPB elements of procedures specified below contain the selection of commands and responses relevant to the LAPB link and system configurations described in 2.1 above. Together, 2.2 and 2.3 form the general requirements for the proper management of a LAPB access link.

2.3.2 LAPB control field formats and parameters

2.3.2.1 Control field formats

The control field contains a command or a response, and sequence numbers where applicable.

Three types of control field formats are used to perform numbered information transfer (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/X.25.

TABLE 3/X.25

LAPB control field formats - Basic (modulo 8) operation

Control Field Bits	1	2	3	4	5	6	7	8
I Format	0	N(S)			p	N(R)		
S Format	1	0	S	S	P/F	N(R)		
U Format	1	1	M	M	P/F	M	M	M

N(S) Transmitter send sequence number (bit 2 = low-order bit)
N(R) Transmitter receive sequence number (bit 6 = low-order bit)
S Supervisory function bit
M Modifier function bit
P/F Poll bit when issued as a command, final bit when issued as a response (1 = Poll/Final)
P Poll bit (1 = Poll)

Table 4/X.25 (LAPB control field formats - Extended (modulo 128) operation) is not applicable in the XI environment.

2.3.2.1.1 Information transfer format - I

The I format is used to perform an information transfer. The functions of N(S), N(R) and P are independent; i.e., each I frame has an N(S) and N(R) 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.

2.3.2.1.2 Supervisory format - S

The S format is used to perform data link supervisory control functions such as acknowledge I frames, request retransmission of I frames, and to request a temporary suspension of transmission of I frames. The functions of N(R) and P/F are independent; i.e., each supervisory frame has an N(R) 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.

2.3.2.1.3 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 unnumbered frames have the same control field length (one octet) is 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 are described below.

2.3.2.2.1 Modulus

Each I frame is sequentially numbered and may have the value 0 through modulus minus 1 (where "modulus" is the modulus of the sequence numbers). The modulus equals 8 and the sequence cycle through the entire range.

2.3.2.2.2 Send state variable V(S)

The send state variable V(S) denotes the sequence number of the next in-sequence I frame to be transmitted. V(S) can take on the value 0 through modulus minus 1. The value of V(S) is incremented by I with each successive I frame transmission, but cannot exceed N(R) of the last received I or supervisory frame by more than the maximum number of outstanding I frames (k). The value of k is defined in 2.4.8.6. below.

2.3.2.2.3 Send sequence number N(S)

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

2.3.2.2.4 Receive state variable V(R)

The receive state variable V(R) denotes the sequence number of the next in-sequence I frame expected to be received. V(R) can take on the value 0 through modulus minus 1. The value of V(R) is incremented by 1 by the receipt of an error-free, in-sequence I frame whose send sequence number N(S) equals the receive state variable V(R).

2.3.2.2.5 Receive sequence number N(R)

All I frames and supervisory frames contain N(R), the expected send 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 N(R) is set equal to the current value of the receive state variable V(R). N(R) indicates that the DCE or DTE transmitting the N(R) has received correctly all I frames numbered up to and including N(R)-1.

2.3.2.2.6 Poll/Final Bit P/F

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

2.3.3 Functions of the Poll/Final Bit

The Poll bit set to 1 is used by the DCE or DTE to solicit (poll) a response from the DTE or DCE, respectively. The Final bit set to 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.

The use of the P/F bit is described in 2.4.3 below.

2.3.4 Commands and Responses

For basic (modulo 8) operation, the commands and response represented in Table 5/X.25 will be supported by the DCE and the DTE.

TABLE 5/X.25

LAPB Commands and Responses - Basic (Modulo 8) Operation

Format	Command	Response	Encoding 1	2	3	4	5	6	7	8
Information transfer	I (information)		0	N(S)			P	N(R)		
Supervisory	RR (receive ready)	RR (receive ready)	1	0	0	0	P/F	N(R)		
	RNR (receive not ready)	RNR (receive not ready)	1	0	1	0	P/F	N(R)		
	REJ (reject)	REJ (reject)	1	0	0	1	P/F	N(R)		
Unnumbered	SABM (set asynchronous balanced mode)		1	1	1	1	P	1	0	0
	DISC(disconnect)		1	1	0	0	P	0	1	0
		DM (discon- nected mode)	1	1	1	1	F	0	0	0
		UA (unnumbe- red acknowl- edgment)	1	1	0	0	F	1	1	0
		FRMR (frame reject)	1	1	1	0	F	0	0	1

Table 6/X.25 (LAPB commands and response - Extended (modulo 128) operation) is not applicable in the XI environment.

For purposes of the LAPB procedures, the supervisory function bit encoding "11" and those encoding of modifier function bits in Tables 5/X.25 or 6/X.25 are identified as "undefined or not implemented" command and response control field.

The commands and responses in Table 5/X.25 are defined as follows:

2.3.4.1 Information (I) Command

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

2.3.4.2 Receive Ready (RR) Command and Response

The receive ready (RR) supervisory frame is used by the DCE or DTE to:

1. Indicate it is ready to receive an I frame

2. Acknowledge previously received I frames numbered up to including N(R)-1.

An RR 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 RR command with the P bit set to 1 may be used by the DCE or DTE to ask for the status of the DTE or DCE, respectively.

In the absence of traffic on the line, the XI DCE starts optionally an inactivity timer Ti. Ti time-out causes the XI DCE to send an RR command, with P bit set to 1. In the absence of an RR response from the DTE, the XI DCE retransmits the RR command, up to N2 times. When the threshold of N2 retries is reached, the XI DCE enters in the disconnected phase.

2.3.4.3 Receive Not Ready (RNR) Command and Response

The receive not ready (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 N(R) - 1 are acknowledged. I frame N(R) and any subsequent I frames received, if any, are not acknowledged; the acceptance status of these I frames will be indicated in subsequent exchanges.

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

2.3.4.4 Reject (REJ) Command and Response

The reject (REJ) supervisory frame is used by the DCE or DTE to request transmission of I frames starting with the frame numbered N(R). I frames numbered N(R) - 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 of information transfer may be established at any time. The REJ exception condition is cleared (reset) upon the receipt of an I frame with an N(S) equal to N(R) 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 the P bit set to 1 may be used by the DCE or DTE to ask for the status of the DTE or DCE, respectively.

XI does not send REJ commands. REJ commands received from a DTE are handled as required by the procedure described here.

2.3.4.5 Set Asynchronous Balanced Mode (SABM) 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 not applicable in the XI environment.

No information field is permitted with the SABM command. The transmission of SABM 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 SABM (modulo 8 (basic) operation) command by the transmission at the first opportunity of a UA response. Upon acceptance of this command, the DCE or DTE send state variable V(S) and receive state variable V(R) are set to 0.

Previously transmitted I frames that are unacknowledged when this command is actioned remain unacknowledged. It is the responsibility of a higher level (e.g., packet level or MLP) to recover from the possible loss of the contents of such I frames.

Modulo 128 is not applicable in the XI environment.

XI never sends SABM frames.

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 sending the DISC command is suspending operation. No information field is permitted with the DISC command. Prior to actioning 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.

Previously transmitted I frames that are unacknowledged when this command is actioned remain unacknowledged. It is the responsibility of a higher level (e.g., Packet Level or MLP) to recover from the possible loss of the contents of such I frames.

The only case where XI sends a DISC frame is when a command is received from the network operator deactivating the DTE/DCE interface. The DISC frame is then sent with P bit set to 1.

2.3.4.7 Unnumbered Acknowledgment (UA) Response

The UA unnumbered response is used by the DCE or DTE to acknowledge the receipt and acceptance of the mode-setting commands. Received mode-setting commands are not actioned until the UA response is transmitted. The transmission of a UA response 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). 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 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 action 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 command as outlined in 2.4.4 below, and will respond with the F bit set to 1 to any other command received with the P bit set to 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 retransmitting of the identical frame: i.e., at least one of the following conditions, which results from the receipt of a valid frame:

1. The receipt of a command or response control field that is undefined or not implemented;

2. The receipt of an I frame with an information field which exceeds the maximum established length,

3. The receipt of an invalid N(R), or

4. The receipt of a frame with an information field which is not permitted or the receipt of a supervisory or unnumbered frame with incorrect length.

An undefined or not implemented control field is any of the control field encoding that are not identified in Tables 5/X.25 or 6/X.25.

A valid N(R) must be within the range from the lowest send sequence number N(S) of the still unacknowledged frame(s) to the current DCE send state variable included (or to the current internal variable x if the DCE 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 five 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/X.25 and 8/X.25.

TABLE 7/X.25

LAPB FRMR Information Field Format - Basic (Modulo 8) Operation

Information 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	V(S)	C/R	V(R)	W	X	Y	Z	0	0	0	0

Rejected frame control field is the control field of the received frame which caused the frame reject.

V(S) is the current send state variable value 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.

V(R) is the current receive state variable value at the DCE or DTE reporting the rejection condition (Bit 14 = low-order bit).

W set to 1 indicates that the control field received and returned in bits 1 through 8 was undefined or not implemented.

X set to 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 of unnumbered frame with incorrect length. Bit W must be set to 1 in conjunction with this bit.

Y set to 1 indicates that the information field received exceeded the maximum established capacity.

Z set to 1 indicates the control field received and returned in bits 1 through 8 contained an invalid N(R).

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

Table 8/X.25 (LAPB FRMR information field format - Extended (modulo 128) operation) is not applicable in the XI environment.

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 Level are described below. Exception conditions described are those situations which may occur as the result of transmission errors, DCE or DTE malfunction, or operational situations.

2.3.5.1 Busy Condition

The busy condition results when the 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 command), RR, REJ, or SABM (modulo 8) frame.

| The XI DCE takes into account the clearing of a busy condition of the DTE by any of the methods described above. The XI DCE clears a busy condition by sending an RR frame.

| The XI DCE enters in a busy condition when a modem or line test is run. It clears its busy condition at the completion of the test.

2.3.5.2 N(S) Sequence Error Condition

The information field of all I frames received whose N(S) does not equal the receive state variable V(R) will be discarded.

An N(S) sequence error exception condition occurs in the receiver when an I frame received contains an N(S) which is not equal to the receive state variable V(R) at the receiver. The receiver does not acknowledge (increment its receive state variable) the I frame causing the sequence error, or any I frame which may follow, until an I frame with the correct N(S) is received.

A DCE or DTE which receives one or more valid I frames having sequence errors or subsequent S format frames (RR, RNR, and REJ) shall accept the control information contained in the N(R) field and the P bit to perform link control functions; e.g., to receive acknowledgment of previously transmitted I frames and to cause the DCE or DTE to respond (P bit set to 1).

The means specified in 2.3.5.2.1 and 2.3.5.2.2 shall be available for initiating the retransmission of lost or errored I frames following the occurrence of a N(S) sequence error condition.

2.3.5.2.1 <u>REJ Recovery</u>

The REJ frame is used by a receiving DCE or DTE to initiate a recovery (retransmitting) following the detection of an N(S) sequence error.

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

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

2.3.5.2.2 <u>Time-out Recovery</u>

If a DCE or DTE, due to a transmission error, 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 a N(S) 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 retransmitting must begin. The retransmitted frame(s) may contain an N(R) and a P bit that is updated from, and therefore different from, the ones contained in the originally transmitted I frame(s).

2.3.5.3 Invalid Frame Condition

Any frame 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:

1. Is not properly bounded by two flags,

2. In basic (modulo 8) operation, contains fewer than 32 bits between flags,

3. Contains a Frame Check Sequence (FCS) error,

4. Contains an address other than A or B (for single link operation) or other than

C or D (for multilink operation).

For those networks that are octet aligned, a detection of non-octet alignment may be made at the Data Link Level 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.

| XI networks are octet aligned.

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 DCE or DTE, this frame rejection exception condition is reported by a FRMR response for appropriate DTE or DCE action, respectively. Once a DCE has established such an exception condition, no additional I frames are accepted until the condition is reset by the DTE, except for examination of the P bit. The FRMR response may be repeated at each opportunity, as specified in 2.4.7.3, until recovery is effected by the DTE, or until the DCE initiates its own recovery.

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) on the incoming channel, the DCE shall wait for a period T3 (see 2.4.8.3) without taking any specific action, waiting for detection of a return to the active channel state (that is, detection of at least one flag sequence). After the period T3, the DCE shall notify the Packet Level 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 link set-up procedures.

| XI does not detect an idle condition on the transmission channel from the DTE, and
| does not take any action whatsoever for the duration of this idle condition.

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

2.4 DESCRIPTION OF THE LAPB PROCEDURE

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 either will support modulo 8 (basic) operation or modulo 128 (extended) operation.

| Modulo 128 is not applicable in the XI environment.

Table 5/X.25 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 is the SABM command.

| Table 6/X.25 is not applicable in the XI environment.

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.

| Multilink operation is not applicable in the XI environment.

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

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

Frames containing command transferred from the DTE to the DCE shall contain the address B for the single link operation and address D for the multilink operation.

Frames containing response transferred from the DTE to the DCE shall contain the address A for the single link operation and address C for the multilink operation.

These address are coded as follows:

	Address	1	2	3	4	5	6	7	8
Single link operation	A	1	1	0	0	0	0	0	0
	B	1	0	0	0	0	0	0	0

| Multilink operation is not applicable in the XI environment.

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

2.4.3 LAPB Procedure for the Use of the P/F Bit

| The DCE or DTE receiving an SABM, DISC, supervisory command, or I frame with the P bit set to 1 will set the F bit to 1 in the next response frame it transmits.

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

The P bit may be used by the DCE in conjunction with the timer recovery condition (see 2.4.5.9 below).

| XI uses the P bit in conjunction with the timer recovery condition as described in 2.4.5.9 below.

Note - Other use of the P bit by the DCE is a subject for further study.

2.4.4 LAPB Procedure for Link Set-up and Disconnection

2.4.4.1 Link Set-up

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

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

| Note that XI does not send SABM frames but uses the DM frame as just described. The DTE/DCE interface is activated by the network operator. This causes the physical level to be set-up. Then the DCE enters the "DCE disconnected" state and issues an unsolicited DM frame (with F-bit set to 0) as described in 2.4.4.4.2, and activates

the link channel towards the DTE (transmission of contiguous flags). The DCE is then ready to accept link set-up by the DTE as described below.

The DTE shall initiate link set-up by transmitting a SABM command to the DCE. If, upon receipt of the SABM command correctly, 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 V(S) and V(R) to zero, and will consider that the link is set up. If, upon receipt of the SABM command correctly, 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 link set-up initialization and will consider that the link is not set up. In order to avoid misinterpretation of the DM response received, it is suggested that the DTE always send its SABM command with the P bit set to 1. Otherwise, it is not possible to differentiate a DM response intended as a denial to 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).

In the "DCE disconnected" state, XI enters the information transfer phase (by sending a UA), if the level of resources (buffers) in the XI node is sufficient. Otherwise, a DM is returned to the DTE.

DCE initiated link set-up is not applicable in the XI environment.

2.4.4.2 Information Transfer Phase

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

When receiving the SABM command while in the information transfer phase, the DCE will conform to the link resetting procedure described in 2.4.7.

2.4.4.3 Link Disconnection

The DTE shall initiate a disconnect of the data link by transmitting a DISC command to the DCE. On correctly receiving a DISC command in the information transfer state, the DCE will send a UA response and enter the disconnected phase. On correctly receiving a DISC command in the disconnect phase, the DCE will send a DM response and remain in the disconnect phase. In order to avoid misinterpretation of the DM response received, it is suggested that the DTE always send its DISC command with the P bit set to 1. Otherwise, it is not possible to differentiate a DM response intended as an indication 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).

The DCE will initiate a disconnect of the data link by transmitting a DISC command to the DTE and starting its Timer T1 (see 2.4.8.1). 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 only case where XI initiates a disconnect is when the network operator sends a command deactivating the interface. The DISC frame is then sent with P bit set to 1.

The DCE, having sent the DISC command, will ignore and discard any frames except a SABM or DISC command, or a UA or DM response received from the DTE. The receipt of a SABM or DISC command from the DTE 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 level recovery action will be initiated. The value of N2 is defined in 2.4.8.4 below.

2.4.4.4 Disconnected Phase

2.4.4.4.1 After having received a DISC command from the DTE and returned a UA response to the DTE, or having received the UA response to a transmitted DISC command, the DCE will enter the disconnected phase.

XI distinguishes two cases, depending whether the DISC has been sent by the DTE ("DTE disconnected" state) or by the DCE ("operator disconnected" state). The XI DCE may also transmit a DM frame (e.g., after N2 unacknowledged I frames have been sent) and enter the "DCE disconnected state" (see 2.4.4.4.2).

In the disconnected phase, the DCE may initiate link set-up. In the disconnected phase, the DCE will react to the receipt of an SABM command as described in 2.4.4.1 above and will transmit a DM response in answer to a received DISC command. When receiving any other command (defined, or undefined or not implemented) with the P bit set to 1, the DCE will transmit a DM response with the F bit set to 1. Other frames received in the disconnected phase will be ignored by the DCE.

XI never initiates link set-up. In the "DTE disconnected" state or in the "DCE disconnected" state, the DCE will accept a SABM frame from the DTE (see 2.4.4.4.2). In the "operator disconnected" state, the DCE will not accept a SABM (i.e., replies with a DM frame).

2.4.4.4.2 When the DCE 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 DCE will transmit a DM response and start its Timer T1 (see 2.4.8.1 below).

When XI detects an error condition, it sends an unsolicited DM frame as described above, enters a "DCE disconnected" state, and accepts SABM frames from the DTE, as for the "DTE disconnected" state.

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

After N2 transmissions of the DM frames, the XI DCE stays in the "DCE disconnected" state, waiting indefinitely for an SABM from the DTE or a deactivation of the interface by the network operator. No recovery procedure is initiated by the DCE.

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

2.4.4.5 Collision of Unnumbered Commands

Collision situations shall be resolved in the following way:

2.4.4.5.1 If the sent and received unnumbered commands are the same, the DCE and DTE shall send the UA response at the earliest possible opportunity. The DCE shall enter the indicated phase either 1) After receiving the UA response, 2) After sending the UA response, or 3) After timing out waiting for the UA response having sent a UA response. In the case of 2) above, the DCE will accept a subsequent UA response to the mode-setting command it issued without causing an exception condition if received within the time-out interval.

2.4.4.5.2 If the sent and received unnumbered commands are different, the DCE and DTE shall enter the disconnected phase and issue a DM response at the earliest possible opportunity.

2.4.4.6 Collision of DM Response with SABM or DISC Command

When a DM response is issued by the DCE or DTE as an unsolicited response to request the DTE or DCE, respectively, to issue a mode-setting command as described in 2.4.4.4, a collision between a SABM or DISC command and the unsolicited DM response may occur. In order to avoid misinterpretation of the DM response received, the DTE always sends its SABM or DISC command with the P bit set to 1.

2.4.4.7 Collision of DM Responses

A contention situation may occur when both the DCE and the DTE issue a DM response to request a mode-setting command. In this case, the DTE will issue a SABM 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 during the information transfer phase are described below.

In the following, "number one higher" is in reference to a continuously repeated sequence series, i.e., 7 is 1 higher than 6 and 0 is 1 higher than 7 for modulo 8 series, and 127 is 1 higher than 126 and 0 is 1 higher than 127 for modulo 128 series.

2.4.5.1 Sending I Frames

When the DCE 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), it will transmit it with an N(S) equal to its current sent state variable V(S), and an N(R) equal to its current receive state variable V(R). At the of the transmission of the I frame, the DCE will increment its send state variable V(S) by 1.

If Timer T1 is not running at the time of transmission of an I frame, it will be started.

If the send state variable V(S) is equal to the last value of N(R) received plus k (where k is the maximum number of outstanding I frames see 2.4.8.6 below), the DCE will not transmit any new I frames, but may retransmit an I frame as described in 2.4.5.6 or 2.4.5.9 below.

When the DCE is in the busy condition, it may still transmit I frames, provided that the DTE is not busy. When the DCE is in the frame rejection condition, it will stop transmitting I frames.

2.4.5.2 Receiving an I Frame

When the DCE is not in a busy condition and receives a valid I frame whose send sequence number N(S) is equal to the DCE receive state variable V(R), the DCE will accept the information field of this frame, increment by one its receive state variable V(R), and act as follows:

a. If the DCE is still not in a busy condition:

   1) If an I frame is available for transmission by the DCE, it may act as in 2.4.5.1 above and acknowledge the received I frame by setting N(R) in the control field of the next transmitted I frame to the value of the DCE receive state variable V(R). Alternatively, the DCE may acknowledge the received I frame by transmitting an RR frame with the N(R) equal to the value of the DCE receive state variable V(R).

2) If no I frame is available for transmission by the DCE, it will transmit an RR frame with N(R) equal to the value of the DCE receive state variable V(R).

b. If the DCE is now in a busy condition, it will transmit an RNR frame with N(R) equal to the value of the DCE receive state variable V(R) (see 2.4.5.8).

When the DCE is in a busy condition, it may ignore the information field contained in any received I frame.

When possible, XI acknowledges a received I frame using the N(R) field in an I frame transmitted to the DTE.

XI ignores the information field of I frames received when in a busy condition, but takes into account the N(R) value.

2.4.5.3 Reception of Invalid Frames

When the DCE 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 the DCE receives a valid I frame whose send sequence number N(S) is incorrect, i.e., not equal to the current DCE receive state variable V(R), it will discard the information field of the I frame and transmit an REJ frame with the N(R) set to one higher than the N(S) of the last correctly received I frame. The REJ frame will be a command frame with the P bit set to 1 if an acknowledged transfer of the retransmitting request is required: otherwise the REJ frame may be a command or a response frame. The DCE 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 DCE will then acknowledge the I frame as described in 2.4.5.2 above. The DCE will use the N(R) and P bit information in the discarded I frames as described in 2.3.5.2 above.

XI only sends REJ frames as response frames.

2.4.5.5 Receiving Acknowledgment

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

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

2.4.5.6 Receiving a REJ Frame

When receiving a REJ frame, the DCE will set its send state variable V(S) to the N(R) received in the REJ control field. It will 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. (Re)transmission will conform to the following procedure:

1. If the DCE is transmitting a supervisory command or response when i t receives the REJ frame, it will complete that transmission before commencing transmitting of the requested I frame.

2. If the DCE is transmitting an unnumbered command or response when it receives the REJ frame, it will ignore the request for retransmitting.

3. XI does not abort frames.

4. If the DCE is not transmitting any frame when the REJ frame is received, it will commence transmission of the request 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 DCE following the retransmitting of the requested I frame. Other I frames not yet transmitted may be transmitted following the retransmitted I frames.

If the REJ frame was received from the DTE as a command with the P bit set to 1, the DCE will transmit an RR, RNR or REJ response with the F bit set to 1 before transmitting or retransmitting the corresponding I frame.

2.4.5.7 Receiving an RNR Frame

After receiving an RNR frame, the DCE may transmit or retransmit the I frame with the send sequence number equal to the N(R) indicated in the RNR frame and start Timer T1, if not already running. If Timer T1 runs out before receipt of a busy clearance indication, the DCE will follow the procedure described in 2.4.5.9 below. In any case, the DCE will not transmit any other I frames before receiving an RR or REJ frame, or before the completion of a link resetting procedure.

Alternatively, after receiving an RNR frame, the DCE may wait for a period of time (e.g., the length of the Timer T1) and then transmit a supervisory command frame (RR, RNR or REJ) with the P bit set to 1, and start Timer T1, in order to determine if there is any change in the receive status of the DTE. The DTE shall respond to the P bit set to 1 with a supervisory response frame (RR, RNR or REJ) with the F bit set to 1 indicating either continuance of the busy condition (RNR) or clearance of the busy condition (RR or REJ). Upon receipt of the DTE response, Timer T1 is stopped.

XI makes use of the second alternative, where the DCE issues an RR command with P bit set to 1 after a period equal to T1. It does so only if there are I frames waiting for acknowledgment on the DCE side.

1. If the response is the RR or REJ response, the busy condition is cleared and the DCE may transmit I frames beginning with the I frame identified by the N(R) in the received response frame.

2. If the response is the RNR response, the busy condition still exists, and the DCE will after a period of time (e.g., the length of Timer T1) repeat the enquiry of the DTE receive status.

If Timer T1 runs out before a 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 DCE will initiate a link resetting procedure as described in 2.4.7.2 below or will transmit a DM response to ask the DTE to initiate a 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 from the DTE, it will be considered to be an indication of clearance of the busy condition. Should the unsolicited RR or REJ frame be a command frame with the P bit set to 1 the appropriate response frame with the F bit set to 1 must be transmitted before the DCE may resume transmission of I frames. If Timer T1 is running, the DCE will wait for the non-busy response with the F bit set to 1, or will wait for Timer T1 to run out and then either may reinitiate the enquiry process in order to realize a successful P/F bit exchange or may resume transmission of I frames beginning with the I frame identified by the N(R) in the received RR or REJ frame.

When the busy condition is cleared by the DTE, XI immediately resumes the transmission of any pending I frames.

2.4.5.8 DCE Busy Condition

When the DCE enters a busy condition, it will transmit an RNR frame at the earliest opportunity. The RNR frame will be a command frame with the P bit set to 1 if an acknowledged transfer of the busy condition indication is required: otherwise the RNR frame may be either a command or a response frame. While in the busy condition, the DCE will accept and process supervisory frames, will accept and process the controls of the N(R) fields of I frames, and will return an RNR response with the F bit set to 1 if it receives a supervisory command or I command frame with the P bit set to 1. To clear the busy condition, the DCE will transmit either a REJ frame or a RR frame, with N(R) set to the current receive state variable V(R), depending on whether or not it discarded information fields of correctly received I frames. The REJ frame or the RR frame or the frame will be a command frame with the P bit set to 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.

XI may enter a busy condition when the level of resources of the XI node (buffers) goes under a threshold defined by the network service provider.

XI will enter a busy condition when modem or line tests are run, at the request of the network operator.

2.4.5.9 Waiting Acknowledgment

The DCE maintains an internal transmission attempt variable which is set to 0 when the DCE sends a UA response, when the DCE receives a UA response or an RNR command or response, or when the DCE correctly receives an I frame or supervisory frame with the N(R) higher than the last received N(R) (actually acknowledging some outstanding I frames).

If Timer T1 runs out waiting for the acknowledgment from the DTE for an I frame transmitted, the DCE will enter the Timer recovery condition, add one to its transmission attempt variable and set an internal variable x to the current value of its send state variable V(S).

The DCE will restart Timer T1, set its send state variable V(S) to the value of N(R) received from the DTE and retransmit the corresponding I frame with the P bit set to 1, or transmit an appropriate supervisory command frame (RR, RNR or REJ) with the P bit set to 1.

XI makes use of the second method, i.e. issues a supervisory command (in principle an RR command) with the P bit set to 1.

The timer recovery condition is cleared when the DCE receives a valid supervisory frame with the F bit set to 1.

If, while in the timer recovery condition, the DCE correctly receives a supervisory frame with the F bit set to 1 and with the N(R) within the range from its current send state variable V(S) to x included, it will clear the timer recovery condition (including stopping Timer T1) and set its send state variable V(S) to the value of the received N(R), and may then resume with I frame transmission or retransmitting, as appropriate.

If, while in the timer recovery condition, the DCE correctly receives an I or supervisory frame with the P/F bit set to 0 and with a valid N(R) (see 2.3.4.9), it will not clear the timer recovery condition. The value of the received N(R) may be used to update the send state variable V(S).

XI accepts the N(R) information of a frame with the F bit set to 0 when it is in timer recovery condition.

If the received supervisory frame with the P/F bit set to 0 is a REJ frame with a valid N(R), the DCE may either immediately initiate (re)transmission from the value of the send state variable V(S), or it may ignore the request for retransmission and wait until the supervisory frame with the F bit set to 1 is received before initiating (re)transmission of frames from the value identified in the N(R) field of the F=1 supervisory frame.

XI waits for a supervisory frame with the F bit set to 1 before resuming the transmission of I frames.

If, while in the timer recovery condition, the DCE receives a REJ command with the P bit set to 1, the DCE will respond immediately with an appropriate supervisory response with the F bit set to 1. The DCE may then use the value of the N(R) in the REJ command to update the send state variable V(S), and may either immediately begin (re)transmission from the value N(R) indicated in the REJ frame or ignore the request for retransmitting and wait until the supervisory frame with the F bit set to 1 is received before initiating (re)transmission of I frames the value identified in the N(R) field of the F = 1 supervisory frame.

| XI waits for a supervisory frame with the F bit set to 1 before resuming the
| transmission of I frames.

If Timer T1 runs out in the timer recovery condition, and no I supervisory frame with the P/F bit set to 0 and a valid N(R) has been received, or no REJ command with the P bit set to 1 and with a valid N(R) has been received, the DCE will add one to its transmission attempt variable, restart Timer T1, and either retransmit the I frame sent with the P bit set to 1 or transmit an appropriate supervisory command with the P bit set to 1.

| XI makes use of the second method, i.e., issues a supervisory command with the P bit
| set to 1.

If the transmission attempt variable is equal to N2, the DCE will initiate a link resetting procedure as described in 2.4.7.2 below, or will transmit a DM response to ask the DTE to initiate a link set-up procedure as described in 2.4.4.1 and enter the disconnected phase. N2 is a system parameter (see 2.4.8.4).

| XI makes use of the second method, i.e., issues a DM frame and enters the "DCE
| disconnected" state, where it accepts an SABM or DISC from the DTE.

Note - Although the DCE may implement the internal variable X, other mechanisms do exist that achieve the identical function.

2.4.6 LAPB Conditions for Link Resetting or Link Re-initialization (Link Set-up)

2.4.6.1 When the DCE receives, during the information transfer phase, a frame which is not invalid (see 2.4.5.3) with one of the conditions listed in 2.3.4.9, the DCE will request the DTE to initiate a link resetting procedure by transmitting an FRMR response to the DTE as described in 2.4.7.3.

2.4.6.2 When the DCE receives, during the information transfer phase, an FRMR response from the DTE, the DCE will either initiate the link resetting procedure itself as described in 2.4.7.2 or return a DM response to ask the DTE to initiate the link set-up (initialization) procedure as described in 2.4.4.1. After transmitting a DM response, the DCE will enter the disconnected phase as described in 2.4.4.4.2.

| XI makes use of the second method, i.e., issues a DM frame and enters the "DCE
| disconnected" state, where it accepts a SABM or DISC from the DTE.

2.4.6.3 When the DCE receives, during the information transfer phase, a UA response, or an unsolicited response with the F bit set to 1, the DCE may either initiate the link resetting procedure itself as described in 2.4.7.2, or return a DM response to ask the DTE to initiate the link set-up (initialization) procedure as described in 2.4.4.1. After transmitting a DM response, the DCE will enter the disconnected phase as described in 2.4.4.2.

| XI makes use of the second method, i.e., issues a DM frame and enters the "DCE
| disconnected" state, where it accepts a SABM or DISC from the DTE.

2.4.6.4 When the DCE receives, during the information transfer phase, a DM response from the DTE, the DCE will either initiate the link set-up (initialization) procedure itself as described in 2.4.4.1, or return a DM response to ask the DTE to initiate the link set-up (initialization) procedures as described in 2.4.4.1. After transmitting a DM response, the DCE will enter the disconnected phase as described in 2.4.4.4.2.

| XI makes use of the second method, i.e., issues a DM frame and enters the "DCE
| disconnected" state, where it accepts a SABM or DISC from the DTE.

2.4.7 LAPB Procedure for Link Resetting

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

2.4.7.2 Either the DTE or the DCE may initiate the link resetting procedure. The link resetting procedure indicates a clearance of a DCE and/or DTE busy condition, if present.

The DTE shall initiate a link resetting by transmitting a SABM command to the DCE. If, upon receipt of the SABM command correctly, the DCE determines that it can continue in the information transfer phase, it will return a UA response to the DTE, will reset its send and receive state variable V(S) and V(R) to zero, and will remain in the information transfer phase. If, upon receipt of the SABM command correctly, the DCE determines that it cannot remain i n the information transfer phase, it will return a DM response as a denial to the resetting request and will enter the disconnected phase.

XI accepts a SABM or DISC command from the DTE except in the "operator disconnected" state. XI never sends SABM but issues DM, enters the "DCE disconnected" state, and accepts a SABM or DISC from the DTE.

DCE initiated link resetting is not applicable in the XI environment.

2.4.7.3 The DCE may ask the DTE to reset the data link by transmitting an FRMR response (see 2.4.6.1 above).

After transmitting an FRMR response, the DCE will enter the frame rejection condition. The frame rejection condition is cleared when the DCE receives or transmits an SABM or DISC command or a DM response . Any other command received while in the frame rejection condition will cause the DCE to retransmit the FRMR response with the same information field as originally transmitted.

The DCE may start Timer T1 on transmission of FRMR response. If Timer T1 runs out before the reception of an SABM or DISC command or a DM response from the DTE, the DCE may retransmit the FRMR response, and restart Timer T1. After N2 attempts to get the DTE to reset the link, the DCE may reset the link itself as described in 2.4.7.2. The value of N2 is defined in 2.4.8.4 below.

The FRMR response is not repeated by XI. At the expiry of timer T1, a DM frame is sent to the DTE and the interface goes into the "DCE disconnected" state.

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

XI makes use of the second method, i.e., issues a DM frame and enters the "DCE disconnected" state, where it accepts a SABM or DISC from the DTE.

2.4.8 List of LAPB System Parameters

The DCE and DTE system parameters are as follows:

2.4.8.1 Timer T1

The value of the DTE Timer T1 system parameter may be different than the value of the DCE Timer T1 system parameter. These values shall be made known to both the DTE and the DCE, and agreed to for a period of time by both the DTE and the DCE.

The DCE timer T1 may be chosen at subscription time between 0.5 sec and 6 sec. The corresponding DTE timer T1 is not known by XI but should preferably be chosen close to the DCE timer T1.

The period of Timer T1, at the end of which retransmitting of a frame may be initiated (see 2.4.4 and 2.4.5 above for the DCE), shall take into account whether T1 is started at the beginning or the end of transmission of a frame.

XI starts timer T1 at the end of the transmission of a frame.

The proper operation of the procedure requires that the transmitter's (DCE or DTE) Timer T1 be greater than the maximum time between transmission of a frame (SABM, 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 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 (see 2.4.8.2).

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

2.4.8.2 Parameter T2

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

The period of parameter T2 shall indicate the amount of time available at the DCE before the acknowledging frame must be initiated in order to ensure its receipt by the DTE or DCE, respectively, prior to Timer T1 running out at the DTE or DCE. $T2 < T1$.

<u>Note:</u> 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 link, the stated processing times 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 link, minus the frame processing time at the DCE, minus the frame processing time at the DTE, and minus the transmission time of the acknowledging frame by the DCE or DTE, respectively.

The DCE timer T2 is optional. It may be chosen at subscription time between 0.5 sec and 6 sec.

2.4.8.3 Timer T3

The timer T3 is not implemented in the XI DCE, i.e., the DTE may consider that T3 has an infinite value.

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 N2 system parameter. These values shall be made known to both the DTE and the DCE, and agreed to for a period of time by both the DTE and the DCE.

The value of N2 shall indicate the maximum number of attempts made by the DCE or DTE to complete the successful transmission of a frame to the DTE or DCE, respectively.

The DCE value of parameter N2 can be chosen from between 3 and 31, independently per access port. XI does not act upon the DTE value of the N2 parameter, which is not a parameter of the access port.

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 N1 system parameter. These values shall be known to both the DTE and the DCE.

The values of N1 shall indicate the maximum number of bits in an I frame (excluding flags and 0 bits inserted for transparency) that the DCE or the DTE is willing to accept from the DTE or DCE respectively.

In order to allow for universal operation, a DTE should support a value of DTE N1 which is not less than 1090 bits (135 octets). DTE should be aware that the network may transmit longer packets (see 5.2), that may result in a link level problem.

All networks shall offer to a DTE which requires it a value of DCE N1 which is greater than or equal to 2092 bits (259 octets) plus 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 fields at the DTE/DCE interface.

The link level of XI accepts frames whose length includes the maximum packet size plus the headers of link and packet levels. Too large packets are handled at packet level according to the procedures in 4 and 5.

2.4.8.6 Maximum Number of Outstanding I Frames K

The value of the DTE K system parameter shall be the same as the DCE K system parameter. This value shall be agreed to for a period of time by both the DTE and DCE.

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 for Modulo 8 operation, or one hundred twenty seven for Modulo 128 operation. All networks (DCEs) shall support a value of seven. Other values of K (less than and greater than seven) may also be supported by networks (DCEs).

For XI, K can be chosen between 1 and 7 with modulo 8. Modulo 128 is not applicable in the XI environment.

2.4.8.7 Inactivity Timer Ti

The timer Ti, **specific to XI**, need not be known or implemented by the DTE. XI DCE starts timer Ti when it is in data transfer phase, has no frame to transmit, and has no outstanding frame (waiting for acknowledgement). This permits checking that the DTE stays logically connected with the DCE, even in the absence of traffic.

Ti is optional. Ti can be subscribed between 1 and 400 seconds, and should be larger than T1. The XI DCE stops timer Ti when it has a frame to transmit or has received a frame.

Upon a time-out of timer Ti, XI DCE sends an RR command with P bit set to 1, which should be replied by the DTE with an RR or RNR response, with F bit set to 1.

2.5 MULTILINK PROCEDURE (MLP) (SUBSCRIPTION-TIME SELECTABLE OPTION)

Multilink procedure (MLP) is not applicable in the XI environment.

2.6 LAP ELEMENTS OF PROCEDURE

Lap elements of procedure are not applicable in the XI environment.

3. DESCRIPTION OF THE PACKET LEVEL DTE/DCE INTERFACE

This and subsequent points of the Recommendation relate to the transfer of packets at the DTE/DCE interface. The procedures apply to packets which are successfully transferred across the DTE/DCE interface.

Each packet to be transferred across the DTE/DCE interface shall be contained within the link level information field which will delimit its length, and only one packet shall be contained in the information field.

XI requires that packets contain an integral number of octets.

If XI receives from the DTE a packet not containing an integral number of octets, the frame containing the packet is discarded.

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.

This point covers a description of the packet level interface for virtual call and permanent virtual circuit services. As designated in Recommendation X.2, virtual call and permanent virtual circuit services are essential (E) services to be provided by all networks.

Procedures for the virtual circuit service (that is, virtual call an d permanent virtual circuit services) are specified in 4. Packet formats are specified in 5. Procedures and formats for optional user facilities are specified in 6 and 7.

3.1 LOGICAL CHANNELS

To enable simultaneous virtual calls and/or permanent virtual circuits, logical channels are used. Each virtual call or permanent virtual circuit is assigned a logical channel group number (less than or equal to 15) and a logical channel number (less than or equal to 255). For virtual calls, a logical channel group number and a logical channel number are assigned during the call set-up phase. The range of logical channels used for virtual calls is agreed with the Administration at the time of subscription to the service (see Annex A). 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 Annex A).

3.2 BASIC 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, a logical channel identifier and a packet type identifier. Other packet fields are appended as required (see 5).

Packet types and their use in association with various services are given in Table 14/X.25.

TABLE 14/X.25

Packet Types and their Use in Various Services

Packet type		Service	
From DCE to DTE	From DTE to DCE	VC	PVC
CALL SET-UP AND CLEARING (see Note 1)			
Incoming call	Call request	X	
Call connected	Call accepted	X	
Clear indication	Clear request	X	
DCE clear confirmation	DTE clear confirmation	X	
DATA AND INTERRUPT (see Note 2)			
DCE data	DTE data	X	X
DCE interrupt	DTE interrupt	X	X
DCE interrupt confirmation	DTE interrupt confirmation	X	X
FLOW CONTROL AND RESET (see Note 3)			
DCE RR	DTE RR	X	X
DCE RNR	DTE RNR	X	X
	DTE REJ (a)	X	X
Reset indication	DTE request	X	X
DCE reset confirmation	DTE reset confirmation	X	X
RESTART (see Note 4)			
Restart indication	Restart request	X	X
DCE restart confirmation	DTE restart confirmation	X	X
DIAGNOSTIC (see Note 5)			
Diagnostic (a)		X	X
REGISTRATION (a)(see Note 6)			
Registration confirmation		X	X
	Registration request	X	X

(a) Not necessarily available on all networks.

VC Virtual call
PVC Permanent virtual circuit

Note 1 - See 4.1 and 6.16 for procedures, 5.2 for formats.

Note 2 - See 4.3 for procedures and 5.3 for formats.

Note 3 - See 4.4 and 6.4 for procedures, 5.4 and 5.7.1 for formats.

Note 4 - See 3.3 for procedures and 5.5 for formats.

Note 5 - See 3.4 for procedures and 5.6 for formats.

Note 6 - See 6.1 for procedures and 5.7.2 for formats.

XI does not offer the packet retransmission additional facility, thu s the DTE REJ packet is not handled.

XI does not offer the online registration facility, thus registration request and registration confirmation packets are not handled.

3.3 PROCEDURE FOR RESTART

The restart procedure is used to initialize or re-initialize the packet level DTE/DCE interface. The restart procedure simultaneously clears all the virtual calls and resets all the permanent virtual circuits at the DTE/DCE interface (see 4.5).

Figure B-1/X.25 gives the state diagram which defines the logical relationships of events related to the restart procedure.

Table C-2/X.25 specifies actions taken by the DCE on the receipt of packets from the DTE for the restart procedure.

3.3.1 Restart by the DTE

The DTE may at any time request a restart by transferring across the DTE/DCE interface a restart request packet. The interface for each logical channel is then in the DTE restart request state (r2).

The DCE will confirm the restart by transferring a DCE restart confirmation packet and placing the logical channels used for virtual calls in the ready state (p1), and the 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 Annex D).

3.3.2 Restart by the DCE

The DCE will indicate a restart by transferring across the DTE/DCE interface a restart indication packet. The interface for each logical channel 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.

The DTE will confirm the restart by transferring a DTE restart confirmation packet and placing the logical channels used for virtual calls in the ready state (p1), and the 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 is given in Annex D.

An XI node initiates a restart procedure each time the link level is set up or re-initialized. With LAPB, a restart procedure is initiated after each complete exchange of SABM and UA frames. Moreover, an XI node also initiates a restart procedure in case of a procedure error from the DTE, as described in Annex C.

3.3.3 Restart Collision

Restart collision occurs when a DTE and a DCE simultaneously transfer a restart request and a restart indication packet. Under these circumstances, the DCE will consider that the restart is completed. The DCE will not expect a DTE restart confirmation packet and will not transfer a DCE restart confirmation packet. This places the logical channels used for virtual calls in the ready state (p1), and the logical channels used for permanent virtual circuits in the flow control ready state (d1).

3.4 ERROR HANDLING

Table C-1/X.25 specifies the reaction of the DCE when special error conditions are encountered. Other error conditions are discussed in 4.

3.4.1 Diagnostic Packet

The diagnostic packet is used by some networks to indicate error conditions under circumstances where the usual methods of indication (that is, reset, clear and restart with cause and diagnostic) are inappropriate (see Tables C-1/X.25 and D-1/X.25). The diagnostic packet from the DCE supplies information on error situations which are considered unrecoverable at the packet level of Recommendation X.25; the information provided permits an analysis of the error and recovery by higher levels at the DTE if desired or possible.

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.

XI makes use of the diagnostic packet to report error conditions to the DTE, as described above.

3.5 EFFECTS OF THE PHYSICAL LEVEL AND THE LINK LEVEL ON THE PACKET LEVEL

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

A failure on the physical and/or link level is 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.

When a failure on the physical and/or link level is detected, the DCE will clear virtual calls and reset permanent virtual circuits. Further actions are specified in 4.6.

In other out of order conditions on the physical and/or link level, the DCE will also clear virtual calls and reset permanent virtual circuits. An out of order condition on the link level includes receipt of a DISC command or transmission of a DISC command by the DCE, in the case of a single link procedure.

When a failure or out of order condition is recovered at physical and link levels, the DCE will send a restart indication packet with the cause "Network operational" to the local DTE. Further actions are specified in 4.6.

When XI has to clear virtual calls and reset permanent virtual circuits because of a change at the link level or at the physical level, the diagnostic code associated with the cause code "out of order" permits the remote DTEs to be aware that they can resume communications with that DTE. The diagnostic code indicates one of the following situations:

- The link level has not been initiated by the DTE, or a restart indication is pending.
- A failure of the line or modems has been detected.
- A DISC or DM frame has been received from the DTE.
- The DTE/DCE interface has been deactivated by the network operator (DISC has been sent by the DCE).

- A SABM frame has been received by the DCE to reinitiate the link level.

- A DM frame has been sent by the DCE, for example; this happens when the maximum number of retransmissions is reached or on receiving an FRMR frame from the DTE.

Moreover, the packet level of XI stores the last significant event at the link level or at the physical level, in order to respond with the same diagnostics to further call attempts or transmission attempts on a PVC.

The codes of such XI specific diagnostics are given in Annex E.

4. PROCEDURES FOR VIRTUAL CIRCUIT SERVICES

4.1 PROCEDURES FOR VIRTUAL CALL SERVICE

Figures B-1/X.25, B-2/X.25 and B-3/X.25 show the state diagrams which define the events at the packet level DTE/DCE interface for each logical channel used for virtual calls.

Annex C gives details of the action taken by the DCE on receipt of packets in each state shown in Annex B.

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

4.1.1 Ready State

If there is no call in existence, a logical channel is in the ready state (p1).

4.1.2 Call Request Packet

The calling DTE shall indicate a call request by transferring a call request packet across the DTE/DCE interface. The logical channel selected by the DTE is then in the DTE waiting state (p2). The call request packet includes the called DTE address. The calling DTE address field may also be used.

Note 1 - A DTE address may be a DTE network address or any other DTE identification agreed for a period of time between the DTE and the DCE.

Note 2 - The call request packet should use the logical channel in the ready state with the highest number in the range which has been agreed with the Administration (see Annex A). Thus the risk of call collision is minimized.

For XI, the DTE is not required to fill the calling DTE address field, which avoids the constraint on the DTE to record its own address. In this case, the calling DTE address is inserted by the XI node. The DTE is nevertheless allowed to give its own address, a portion of its address, or one of its addresses when more than one address has been assigned to that DTE.

The format and the semantics of the addresses that DTEs can handle must be in compliance with XI rules and with the addressing scheme of the XI network which is the responsibility of the network service provider. Possible address formats for XI are quoted in 5.8.

4.1.3 Incoming Call Packet

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

The incoming call packet will use the logical channel in the ready state with the lowest number (see Annex A). The incoming call packet includes the calling DTE address. The called DTE address field may also be used.

Note: A DTE address may be a DTE network address or any other DTE identification agreed for a period of time between the DTE and the DCE.

In an incoming call packet, the XI node gives both the calling DTE address and the called DTE address. The called DTE address must be one of the addresses that have been assigned to that DTE. Possible address formats for XI are quoted in 5.8.

4.1.4 Call Accepted Packet

The called DTE shall indicate its acceptance of the call by transferring across the DTE/DCE interface a call accepted packet specifying the same logical channel as that of the incoming call packet. This places the specified logical channel in the data transfer state (p4).

If the called DTE does not accept the 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 Annex D), the DCE will consider it as a procedure error from the called DTE and will 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 data transfer state (p4).

The time spent in the DTE waiting state (p2) will not exceed time-limit T21 (see Annex D).

4.1.6 Call Collision

Call collision occurs when a DTE and DCE simultaneously transfer a call request packet and an incoming call packet specifying the same logical channel. The DCE will proceed with the call request and cancel the incoming call.

4.1.7 Clearing by the DTE

At any time, the DTE may indicate clearing by transferring across the DTE/DCE interface a clear request packet (see 4.5). The logical channel is then in the DTE clear request state (p6). When the DCE is prepared to free the logical channel, the DCE will transfer across the DTE/DCE interface a DCE clear confirmation packet specifying the logical channel. 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 Annex D).

For XI, the DCE clear confirmation packet has a local significance. When the DCE receives a DTE clear request, it immediately issues the DCE clear confirmation and forwards the clear request, so that the logical channel returns to state P1 without delay.

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.

Note - The calling DTE may abort a call by clearing it before it has received a call connected or clear indication 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.

4.1.8 Clearing by the DCE

The DCE will indicate clearing by transferring across the DTE/DCE interface a clear indication packet (see 4.5). The logical channel is then in the DCE clear indication state (p6). The DTE shall respond by transferring across the DTE/DCE interface a DTE clear confirmation packet. The logical channel is then in the ready state (p1).

The action taken by the DCE when the DTE does not confirm clearing within time-out T13 is given in Annex D.

4.1.9 Clear Collision

Clear collision occurs when a DTE and DCE simultaneously transfer a clear request packet and a clear indication packet specifying the same logical channel. Under these circumstances the DCE will consider that the clearing is completed. The DCE will not expect a DTE clear confirmation packet and will not transfer a DCE 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 will transfer a clear indication packet specifying the logical channel indicated in the call request packet.

4.1.11 Call Progress Signals

The DCE will be capable of transferring to the DTE clearing call progress signals as specified in 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.

4.1.12 Data Transfer State

The procedures for the control of packets between DTE and DCE while in the data transfer state are contained in 4.3.

4.2 PROCEDURES FOR PERMANENT VIRTUAL CIRCUIT SERVICE

Figures B-1/X.25 and B-3/X.25 show the state diagrams which give a definition of events at the packet level DTE/DCE interface for logical channels assigned for permanent virtual circuits.

Annex C gives details of the action taken by the DCE on receipt of packets in each state shown in Annex B.

For permanent virtual circuits there is no call set-up or clearing. The procedures for the control of packets between DTE and DCE while in the data transfer state are contained in 4.3.

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".

For XI, a PVC installation requires first that DCE tables be installed at both ends of the PVC; and secondly that the PVC be activated through an appropriate network operator command (PVC activation). As long as the PVC is not activated, XI reacts as for a temporary inability to handle data traffic, with a cause "out of order" if the DTE has subscribed to the "X.25 1980" parameter, or "network out of order" if the DTE has subscribed to the "X.25 1984" parameter, and an XI specific diagnostic "PVC not activated".

Once the PVC is activated, XI will try to establish and maintain the PVC, independently of the status of the access links of the DTEs. Each time the status of one of the DTE access links is reversed so as to permit data transfer, a DCE reset indication is prepared with the cause "remote DTE operational" and the diagnostic is set to zero to inform the other DTE. This indication is transmitted to the DTE if the status of the access link permits it.

In the case where the DTE access link is not in the ready state, or at any time when the DTE access link is turned to a status which does not permit data transfer, a DCE reset indication is prepared with the cause "out of order" and an XI specific diagnostic "remote access link not operational" to inform the remote DTE. This indication may or not be transmitted to the DTE, depending on the status of the access link, and no further indications are given to the DTEs until there is a change in the status of one of the access links, or a network failure.

A PVC can be deactivated through a network operator command. Both DTEs will receive (if the access link permits it) a DCE reset indication with the cause "out of order", and the XI specific diagnostic "PVC not activated".

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 or permanent virtual circuits existing at the DTE/DCE interface.

Normal network operation dictates that user data in data and interrupt packets are all passed transparently, unaltered through the network in the case of packet DTE to packet DTE communications. The 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 data transfer state (p4) after completion of call establishment and prior to a clearing or a restart procedure. A permanent virtual circuit logical channel is continually in the data transfer state (p4) except during the restart procedure. Data, interrupt, flow control and reset packets may be transmitted and received by a DTE in the data transfer state of a logical channel at the DTE/DCE interface. 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 and reset packets transmitted by a 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.

4.3.2 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 may be offered by Administrations from the following list: 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 DTE/DCE 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).

| XI permits a default maximum user data field length of between 64 and 1024 octets. For each PVC, a value in the same range can be subscribed to. It may be different from the default value, and different at each end of the PVC.

The user data field of data packets transmitted by a DTE or DCE may contain any number of bits up to the agreed maximum.

| Note - XI networks require the user data field to contain an integral number of octets.

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".

4.3.3 Delivery Confirmation Bit

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 P(R) (see 4.4).

Note - The use of the D bit procedure does not obviate the need for a higher level protocol agreed between the communicating 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 remote 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.

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 the 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 the call request and call accepted packets is recommended but is not mandatory for using the D bit procedure during the virtual call.

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.

The M bit can be set to 1 in any data packet. When it is set to 1 in a full data packet or in a partially full data packet also carrying the D bit set to 1, it indicates that more data is to follow. Recombination with the following data packet may only be performed within the network when the M bit is set to 1 in a full data packet which also has the D bit set to 0.

A sequence of data packets with every M bit set to 1 except for the last one will be delivered as a sequence of data packets with the M bit set to 1 except for the last one when the original packets having the M bit set to 1 are either full (irrespective of the setting of the D bit) or partially full but have the D bit set to 1.

Two categories of data packets, A and B, have been defined as shown in Table 15/X.25. Table 15/X.25 also illustrates the network's treatment of the M and D bits at both ends of a virtual call or permanent virtual circuit.

TABLE 15/X.25

Definition of two categories of data packets and network treatment of the M and D bits

Data packet sent by source DTE				Combining with subsequent packet(s) is performed by the network when possible	Data packet (a) received by destination DTE	
Category	M	D	Full		M	D
B	0 or 1	0	No	No	0 (see Note 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 (see Note 2)	1	0
B	1	1	Yes	No	1	1

(a) 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.

Note 1 - The originating network will force the M bit to 0.

Note 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 and D bit settings in the data packet received by the destination DTE will be according to that given in the two 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 the M bit set to 1 and D bit set to 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 a 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 sequence where each packet, except the last one, has the exact maximum user data field length, the M bit set to 1, and the D bit set to 0. The user data field of the last packet of the sequence may have less than the maximum length and the M and D bits are set as described in Table 15/X.25.

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 they have been received by the network, except as follows. If a full packet with the M bit set to 1 and D bit set to 0 is followed by an empty packet, then the two packets may be merged so as to become a single category B full packet.

| XI does not merge a full packet, with the M bit set to 1 and D bit set to 0 with an
| empty packet, into a single packet when the packet sizes are identical at both ends.

If the last packet of a complete packet sequence transmitted by the source DTE has a data field less than the maximum length, the M bit set to 1 and the D bit set to 0, then the last packet of the complete packet sequence delivered to the receiving DTE will have the M bit set to 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 and D bits will be set by the network as described to maintain complete packet sequences.

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 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 (that is, 0 or 1) in all data packets of the same complete packet sequence. 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 Annex C/X.25.

| XI resets the virtual circuit when the Q bit is not set to the same value in a complete
| packet sequence as described in Annex C/X.25.

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

4.3.7 Interrupt Procedure

The interrupt procedure allows a DTE to transmit data to the remote DTE, without following the flow control procedure applying to data packets (see 4.4). The interrupt procedure can only apply in the flow control ready state (d1) within the data transfer state (p4).

The interrupt procedure has no effect on the transfer and flow control procedures applying to the data packets on the virtual call or permanent virtual circuit.

To transmit an interrupt, a DTE transfers across the DTE/DCE interface a DTE interrupt packet. 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/X.25). The DCE, after the interrupt procedure is completed at the remote end, will confirm the receipt of the interrupt by transferring a DCE interrupt confirmation packet. The 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 the remote DTE by transferring across the DTE/DCE interface a DCE interrupt packet containing the same data field as in the DTE interrupt packet transmitted by the remote DTE. A DCE interrupt packet is delivered at or before the point in the stream of data packets at which the DTE interrupt packet was generated. The DTE will confirm the receipt of the DCE interrupt packet by transferring a DTE interrupt confirmation packet.

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 defined as t3c in Recommendation X.135, and is expressed in terms of a 95% probability value.

With XI, the transit delay selection and indication facility is not available. The transit delay, as defined in Recommendation X.135, is the responsibility of the network service provider, and depends upon the network configuration (mainly the maximum number of transit nodes and the speed of inter-node trunks).

4.4 PROCEDURES FOR FLOW CONTROL

Paragraph 4.4 only applies to the data transfer state (p4) and specifies the procedures covering flow control of data packets and reset on each logical channel used for a virtual call or a permanent virtual circuit.

4.4.1 Flow Control

At the DTE/DCE 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 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 DTE/DCE interface, noting that there is a network-dependent limit on the number of data packets which may be in the network on the virtual call or permanent virtual circuit.

4.4.1.1 Numbering of Data Packets

Each data packet transmitted at the DTE/DCE interface for each direction of transmission in 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. Some Administrations will 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. The packet sequence numbering scheme, modulo 8 or 128, is the same for both directions of transmission and is common for all logical channels at the DTE/DCE interface.

XI supports the extended packet sequence numbering facility (modulo 128) as an individual DTE subscription parameter.

Only data packets contain this sequence number called the packet send sequence number P(S).

The first data packet to be transmitted across the DTE/DCE interface for a given direction of data transmission, when the logical channel has just entered the flow control ready state (d1), has a packet send sequence number equal to 0.

4.4.1.2 Window Description

At the DTE/DCE 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 DTE/DCE 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 packet send sequence number 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 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 DTE/DCE 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).

The flow control parameter negotiation facility is supported by XI.

XI permits a default window size of between 1 and 7 (if modulo 8) and between 1 and 15 (if modulo 128). For each PVC, a value in the same range can be selected and may be different from the default value.

4.4.1.3 Flow Control Principles

When the sequence number P(S) of the next data packet to be transmitted by the DCE is within the window, the DCE is authorized to transmit this data packet to the DTE. When the sequence number P(S) of the next data packet to be transmitted by the DCE is outside the window, the DCE will not transmit a data packet to the DTE. The DTE should follow the same procedure.

When the sequence number P(S) of the data packet received by the DCE is the next in sequence and is within the window, the DCE will accept this data packet. A received data packet containing a P(S) that is out of sequence (that is, there is a duplicate or a gap in the P(S) numbering), outside the window, or not equal to 0 for the first data packet after entering the flow control ready state (d1) is considered by the DCE as a local procedure error. The DCE will reset the virtual call or permanent virtual circuit (see 4.4.3). The DTE should follow the same procedure.

A number (modulo 8, or 128 when extended), referred to as a packet receive sequence number P(R), conveys across the DTE/DCE interface information from the receiver for the transmission of data packets. When transmitted across the DTE/DCE interface, a P(R) becomes the lower window edge. In this way, additional data packets may be authorized by the receiver to cross the DTE/DCE interface.

The packet receive sequence number, P(R), is conveyed in data, receive ready (RR), and receive not ready (RNR) packets.

XI will use RNR packets to convey P(R) updates only when the D bit is used by the transmitting DTE. Otherwise, congestion due to the receiving DTE is reported by not changing the lower edge of the window. Cases of congestion in the network are reported using the Reset procedure (see 4.4.3.2).

The value of a P(R) received by the DCE must be within the range from the last P(R) received by the DCE up to and including the packet send sequence number of the next data packet to be transmitted by the DCE. Otherwise, the DCE will consider the receipt of this P(R) as a procedure error and will reset the virtual call or permanent virtual circuit. The DTE should follow the same procedure.

The receive sequence number P(R) is less than or equal to the sequence number of the next expected data packet and implies that the DTE or DCE transmitting P(R) has accepted at least all data packets numbered up to and including P(R)-1.

4.4.1.4 Delivery confirmation

When the D bit is set to 0 in a data packet having P(S) = p, the significance of the returned P(R) corresponding to that data packet (that is, $P(R) \geq p + 1$) is a local updating of the window across the packet level interface so that the achievable throughput is not constrained by the DTE to DTE round trip delay across the network(s).

When the D bit is set to 0 in a data packet, the returned P(R) corresponding to that data packet does not signify that a P(R) has been received from the remote DTE.

When the D bit is set to 1 in a data packet having P(S) = p, the significance of the returned P(R) corresponding to that data packet (that is, $P(R) \geq p + 1$) is an indication that a P(R) has been received from the remote DTE for all data bits in the data packet in which the D bit had originally been set to 1.

Note 1 - A DTE, on receiving a data packet with the D bit set to 1, should transmit the corresponding P(R) as soon as possible in order to avoid the possibility of deadlocks (that is, without waiting for further data packets). A data, RR or RNR packet may be used to convey the P(R) (see Note to 4.4.1.6). Likewise, the DCE is required to send P(R) to the DTE as soon as possible from when the P(R) is received from the remote DTE. When the DTE is not currently operating the D bit procedure, the receipt of a data packet with the D bit set to 1 may be treated by the DTE as an error condition.

Note 2 - If a P(R) for a data packet with the D bit set to 1 is outstanding, local updating of the window will be deferred for subsequent data packets with the D bit set to 0.

XI returns immediately an update of the P(R) for all data packets with the D bit set to 0, provided no congestion condition exists in the network or at the receiving DTE side.

Note 3 - P(R) values corresponding to the data contained in data packets with the D bit set to 1 need not be the same at the DTE/DCE interfaces at each end of a virtual call or a permanent virtual circuit.

Note 4 - If the DTE has sent data packets with the D bit set to 0, the DTE does not have to wait for local updating of the window by the DCE before initiating a resetting or clearing procedure.

4.4.1.5 DTE and DCE Receive Ready (RR) Packets

RR packets are used by the DTE or DCE to indicate that it is ready to receive the W data packets within the window starting with P(R), where P(R) 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 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 P(R) 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 packet or by the initiation of a reset procedure.

The transmission of an RR packet after an RNR packet at the packet level 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 P(R) value corresponding to a data packet which had the D bit set to 1 in the case that additional data packets cannot be accepted.

This is the only case where XI issues a RNR packet.

4.4.2 Throughput Characteristics and Throughput Classes

The attainable throughput on virtual calls and permanent virtual circuits carried at the DTE/DCE interface may vary due to the statistical sharing of transmission and switch resources and is constrained by:

1. The access line characteristics, local window size and traffic characteristics of other logical channels at the local DTE/DCE interface;

2. The access line characteristics, local window size and traffic characteristics of other logical channels at the remote DTE/DCE interface; and

3. The throughput achievable on the virtual call or permanent virtual circuit through the network(s) independent of interface characteristics including number of active logical channels. This throughput may be dependent on network service characteristics such as window rotation mechanisms and/or optional user facilities requested on national/international calls.

The attainable throughput will also be affected by:

1. The receiving DTE flow controlling the DCE;

2. The transmitting DTE not sending data packets which have the maximum data field length;

3. The local DTE/DCE window and/or packet sizes; and

4. The use of the D bit.

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. This characteristic is meaningful when the D bit is set to 0 in data packets. It is a measure of the throughput that is not normally exceeded on the 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.

Depending on the network and the applicable conditions at the considered moment, the effective throughput may exceed the throughput class.

Note - The definition of throughput class as a grade of service parameter is for further study. The grade of service might be specified when the D bit is set to 0 or over a time period between the completion and initiation of successive D bit procedures.

The throughput class can only be reached if the following conditions are met:

1. The access data links of both ends of a virtual call or permanent virtual circuit are engineered for the throughput class;

2. The receiving DTE is not flow controlling the DCE such that the throughput class is not attainable;

3. The transmitting DTE is sending data packets which have the maximum data field length; and

4. All data packets transmitted on the virtual call or permanent virtual circuit have the D bit set to 0.

The throughput class is expressed in bits per second. At a DTE/DCE interface, the maximum 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 that the DTE does not have a need to exceed.

In the absence of the default throughput classes 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.

Note - The sum of the 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.

The maximum throughput class supported by an XI network depends upon the network configuration and is the responsibility of the network service provider.

XI supports (as a subscription parameter) the default throughput class assignment facility. Default throughput classes must be lower than or equal to the user class of service of the DTE (access link speed).

XI does not support the throughput class negotiation facility.

The throughput class of a virtual call will be taken as the lowest value between the default throughput class of the calling DTE (or the DTE access link speed if no default throughput class is selected) and the default throughput class of the called DTE (or the DTE access link speed if no default throughput class is selected).

4.4.3 Procedure for Reset

The reset procedure is used to re-initialize the virtual call or permanent virtual circuit and in so doing removes in each direction all data and interrupt packets which may be in the network (see 4.5). When a virtual call or permanent virtual circuit at the DTE/DCE interface has just been reset, the window related to each direction of data transmission has a lower window edge equal to 0, and the numbering of subsequent data packets to cross the DTE/DCE interface for each direction of data transmission shall start from 0.

The reset procedure can only apply in the data transfer state (p4) of the DTE/DCE interface. In any other state of the DTE/DCE interface, 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/X.25. When entering state p4, the logical channel is placed in state d1. Table C-4/X.25 specifies actions taken by the DCE on the receipt of packets from the DTE.

4.4.3.1 Reset Request Packet

The DTE shall indicate a request for reset by transmitting a reset request packet specifying the logical channel to be reset. This places the logical channel 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 logical channel in the DCE reset indication state (d3). In this state, the DCE will ignore data, interrupt, RR and RNR packets.

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. Under these circumstances the DCE will consider that the reset is completed. The DCE will not expect a DTE reset confirmation packet and will not transfer a DCE reset confirmation packet. This places the logical channel in the flow control ready state (d1).

4.4.3.4 Reset Confirmation Packets

When the logical channel is in the DTE reset request state (d2), the DCE will confirm reset by transmitting to the DTE a DCE reset confirmation packet. This places the logical channel in the flow control ready state (d1).

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 Annex D).

XI offers a local significance to the DCE reset confirmation, in that the DCE reset confirmation packet is sent back to the DTE immediately after reception by the DCE of a DTE reset request, while the reset procedure is forwarded to the remote DTE. This is done in compliance with the requirements of 4.5.

When the logical channel is in the DCE reset indication state (d3), the DTE will confirm reset by transmitting to the DCE or a DTE reset confirmation packet. 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 is given in Annex D.

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 DTE or the DCE 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 the 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 the completion of the corresponding reset procedure at the remote interface.

When a DTE initiates a clear, reset or restart procedure at 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 be either delivered to the initiating DTE before DCE confirmation of the initial clear, reset or restart request, or be discarded by the network.

Data packets waiting in an XI node for transmission on a DTE access line or on a line to another node are discarded when the restart, clear, or reset procedure is initiated in that node.

Note - The maximum number of packets which may be discarded is a function of network end-to-end delay and throughput characteristics and, in general, has no relation to the local window size. For virtual calls and permanent virtual circuits on which all data packets are transferred with the D bit set to 1, the maximum number of packets which may be discarded in one direction of transmission is not larger than the window size of the direction of transmission.

4.6 EFFECTS OF PHYSICAL AND LINK LEVEL FAILURES

When a failure at the physical and/or link level 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.

During the failure:

1. The DCE will clear any incoming virtual call with the cause "Out of order";

2. 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";

3. 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 the failure is recovered on the physical and link levels, the restart procedure will be actioned (see 3.5) and a reset with the cause "Remote DTE operational" will be transmitted to the remote end of each permanent virtual circuit.

5. PACKET FORMATS

5.1 GENERAL

The possible extension of packet formats by the addition of new fields is for further study.

Note - Any such field:

1. Would only be provided as an addition following all previously defined fields, and not as an insertion between any of the previously defined fields

2. 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)

3. 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).

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 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/X.25).

Bit 8 of the general format identifier is used for the Qualifier bit in data 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.

Bits 6 and 5 are encoded for four possible indications. Two of the codes are used to distinguish packets using modulo 8 sequence numbering from packets using modulo 128 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 a subject of further study. The fourth code is reserved for other applications.

Note 1 - The DTE must encode the GFI to be consistent with whether or not it has subscribed to the extended packet sequence numbering facility (see 6.2).

Note 2 - It is envisaged that other general format identifier codes could identify alternative packet formats.

TABLE 16/X.25

General format identifier

General format identifier		Octet 1 Bits 8 7 6 5
Call set-up packets	Sequence numbering scheme modulo 8	0 X 0 1
	Sequence numbering scheme modulo 128	0 X 1 0
Clearing, 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 all zeros.

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 all zeros.

5.1.4 Packet Type Identifier

Each packet shall be identified in octet 3 of the packet according to Table 17/X.25.

With XI, the packet retransmission additional facility is not available, thus the DTE REJ packet is not handled.

Also the online registration facility is not available, thus registration request and registration confirmation packets are not handled.

| In both cases, when such packets are sent by the DCE, the DCE reacts as indicated in Annex C (restart, clear, or reset sent to the DTE).

TABLE 17/X.25

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	Call request	0	0	0	0	1	0	1	1
Call connected	Call accepted	0	0	0	0	1	1	1	1
Clear indication	Clear request	0	0	0	1	0	0	1	1
DCE clear confirmation	DTE clear confirmation	0	0	0	1	0	1	1	1
DATA AND INTERRUPT									
DCE data	DTE data	X	X	X	X	X	X	X	0
DCE interrupt	DTE interrupt	0	0	1	0	0	0	1	1
DCE interrupt confirmation	DTE interrupt confirmation	0	0	1	0	0	1	1	1
FLOW CONTROL AND RESET									
DCE RR (modulo 8)	DTE RR (modulo 8)	X	X	X	0	0	0	0	1
DCE RR (modulo 128)(a)	DTE RR (modulo 128)(a)	0	0	0	0	0	0	0	1
DCE RNR (modulo 8)	DTE RNR (modulo 8)	X	X	X	0	0	1	0	1
DCE RNR (modulo 128)(a)	DTE RNR (modulo 128)(a)	0	0	0	0	0	1	0	1
	DTE REJ (modulo 8)(a)	X	X	X	0	1	0	0	1
	DTE REJ (modulo 128)(a)	0	0	0	0	1	0	0	1
Reset indication	Reset request	0	0	0	1	1	0	1	1
DCE reset confirmation	DTE reset confirmation	0	0	0	1	1	1	1	1
RESTART									
Restart indication	Restart request	1	1	1	1	1	0	1	1
DCE restart confirmation	DTE restart confirmation	1	1	1	1	1	1	1	1
DIAGNOSTIC									
Diagnostic(a)		1	1	1	1	0	0	0	1
REGISTRATION(a)									
	Registration request	1	1	1	1	0	0	1	1
Registration confirmation		1	1	1	1	0	1	1	1

(a) Not necessarily available on all networks.

Note - A bit which is indicated as "X" may be set to either 0 or 1 as indicated in the text.

5.2 CALL SET-UP AND CLEARING PACKETS

5.2.1 Call Request and Incoming Call Packets

Figure 2/X.25 illustrates the format of call request and incoming call packets.

Octets	Bits 8	7	6	5	4	3	2	1
1	General format identifier (see Note 1)				Logical channel group number			
2	Logical channel number							
3	Packet type identifier							
	0	0	0	0	1	0	1	1
4	Calling DTE address length				Called DTE address length			
	DTE address(es) (see Note 2)							
					0	0	0	0
	Facility length							
	Facilities							
	Call user data							

Note 1 - Coded 0X01 (modulo 8) or 0X10 (modulo 128).

Note 2 - The figure is drawn assuming the total number of address digits present is odd.

FIGURE 2/X.25

Call request and incoming call packet format

5.2.1.1 General Format Identifier

Bit 7 of octet 1 should be set to 0 unless the mechanism defined in 4.3.3 is used.

5.2.1.2 Address Length Fields

Octet 4 consists 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 address length indicator is binary coded and bit 1 or 5 is the low order bit of the indicator.

5.2.1.3 Address Field

Octet 5 and the following octets consist of the called DTE address when present, then the calling DTE address when present.

Each digit of an address is coded in a semi-octet 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 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.

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.

Note - This field may be used for optional addressing facilities such as abbreviated addressing. The optional addressing facilities employed as well as the coding of those facilities are for further study.

| The format of XI DTE addresses in an XI environment is described in 5.8.

5.2.1.4 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.

5.2.1.5 Facility Field

The facility field is present only when the DTE is using an optional user facility requiring some indication in the call request and incoming call packets.

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.

5.2.1.6 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.

| Note - XI networks require the call user data field to 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 call user data field. See Recommendation X.244.

5.2.2 Call Accepted and Call Connected Packets

Figure 3/X.25 illustrates the format of call accepted and call connected packets in the basic or extended format.

Octets	Bits 8 7 6 5	Bits 4 3 2 1	
1	General format identifier (see Note 1)	Logical channel group number	
2	Logical channel number		
3	Packet type identifier 0 0 0 0	 1 1 1 1	
4	Calling DTE address length	Called DTE address length	(a)
5	DTE address(es) (see Note 2)	0 0 0 0	(a)
	Facility length		(a)
	Facilities		(a)
	Called user data(b)		

(a) These fields are not mandatory in the basic format of 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 1 - Coded 0X01 (modulo 8) or 0X10 (modulo 128).

Note 2 - The figure is drawn assuming the total number of address digits present is odd.

FIGURE 3/X.25

Call accepted and call connected packet format

5.2.2.1 Basic Format

5.2.2.1.1 General Format Identifier

Bit 7 of octet 1 should be set to 0 unless the mechanism defined in 4.3.3 is used.

5.2.2.1.2 Address Length Fields

Octet 4 consists 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 address length indicator is binary coded and bit 1 or 5 is the low order bit of the indicator.

The use of the address length fields in call accepted packets is only mandatory when the address field or the facility length field is present.

5.2.2.1.3 Address Field

Octet 5 and the following octets consist of the called DTE address when present, then the calling DTE address when present.

Each digit of an address is coded in a semi-octet 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 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.

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.

Note - This field may be used for optional addressing facilities such as abbreviated addressing. The optional addressing facilities employed as well as the coding of those facilities is for further study.

| The format of XI DTE addresses in an XI environment is given at the end of 5.8.

5.2.2.1.4 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.

The use of the facility length field in call accepted packets is only mandatory when the facility field is present.

5.2.2.1.5 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 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.

5.2.2.2 Extended Format

| The extended format is not supported by XI, because XI does not support the fast select
| facility which would require the use of the extended format.

5.2.3 Clear Request and Clear Indication Packets

Figure 4/X.25 illustrates the format of clear request and clear indication packets, in basic and extended formats.

Octets	Bits 8 7 6 5	Bits 4 3 2 1	
1	General format identifier (see Note 1)	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(a)		
6	Calling DTE address length	Called DTE address length	(b)
7	DTE address(es) (see Note 2)	0 0 0 0	(b)
	Facility length		(b)
	Facilities		(b)
	Clear user data		(b)

(a) This field is not mandatory in the basic format of clear request packets.

(b) Used only in the extended format (see 5.2.3.2).

Note 1 - Coded 0001 (modulo 8) or 0010 (modulo 128).

Note 2 - The figure is drawn assuming the total number of address digits present is odd.

FIGURE 4/X.25

Clear request and clear indication packet format

5.2.3.1 Basic Format

5.2.3.1.1 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:

```
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.

See the note below Table 18/X.25 for the values allowed for a DTE attached to an XI node.

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 Annex C.

XI considers a "not-permitted" cause field issued by a DTE as an error and will take the actions described in Annex C.

The coding of the clearing cause field in clear indication packets is given in Table 18/X.25.

TABLE 18/X.25

Coding of Clearing Cause Field in Clear Indication Packet

	Bits							
	8	7	6	5	4	3	2	1
DTE originated	0	0	0	0	0	0	0	0
DTE originated(a)	1	X	X	X	X	X	X	X
Number busy	0	0	0	0	0	0	0	1
Out of order	0	0	0	0	1	0	0	1
Remote procedure error	0	0	0	1	0	0	0	1
Reverse charging acceptance not subscribed(b)	0	0	0	1	1	0	0	1
Incompatible destination	0	0	1	0	0	0	0	1
Fast select acceptance not subscribed(b)	0	0	1	0	1	0	0	1
Ship absent(c)	0	0	1	1	1	0	0	1
Invalid facility request	0	0	0	0	0	0	1	1
Access barred	0	0	0	0	1	0	1	1
Local procedure error	0	0	0	1	0	0	1	1
Network congestion	0	0	0	0	0	1	0	1
Not obtainable	0	0	0	0	1	1	0	1
RPOA out of order(b)	0	0	0	1	0	1	0	1

a. When bit 8 is set to 1, the bits represented by Xs are those included by the remote DTE in the clearing or restarting cause field of the clear or restart request packet respectively.
Table 18.1/X.25 gives the different clearing cause values accepted or generated by XI, or generated by DTEs in restart request packets, and delivered on SVCs.

b. May be received only if the corresponding optional user facility is used.

c. Used in conjunction with mobile maritime services.

The cause codes generated by a DCE in an XI node are controlled by a cause qualifier parameter. This parameter is chosen by the network provider to be either 'standard' or 'specific':

- When the cause qualifier parameter value is "standard", and the DTE has subscribed to the 1984 version of X.25, the values of the cause field for a DTE are those in Table 18/X.25. The values which may be sent to DTEs attached to the XI network are those in Table 18/X.25, irrespective of the origin of the clear (the XI network or a PSDN connected through a GW-DTE function).

  However, when clears are passed to a PSDN through the GW-DTE function, bit 8 of the cause field is set to 1 so as to comply with the Recommendation, irrespective of the origin of the clear (the DTE on the XI network or the XI network itself), provided the PSDN accepts it (see Table 18.1/X.25).

- When the cause qualifier parameter value is "specific", the values generated by the XI network are those in Table 18/X.25 <u>with bit 8 set to 1.</u> Clears issued by a PSDN are those in Table 18/X.25, and thus can be differentiated from clears issued by the XI network. A DTE attached to the PSDN will also be capable of differentiating the network origin of the clear.

Table 18.1/X.25 summarizes XI handling for various combinations of DTEs, GW-DTE, and XI parameters.

<u>Notes</u>:

vvvvvvv is bits 7 to 1 of any cause code explicitly shown in Table 18/X.25
nnnnnnn is any bit value other than vvvvvvv.

DTE 80 is a DTE attached to the XI network with parameter "X.25 1980"
DTE 84 is a DTE attached to the XI network with parameter "X.25 1984"

GW 80 is a GW-DTE towards a PSDN based on the 1980 version of X.25
GW 84 is a GW-DTE towards a PSDN based on the 1984 version of X.25.

TABLE 18.1/X.25 (part 1 of 2)

XI Handling of Clearing Causes

Source	CAUSE QUALIFIER = STANDARD				
	Valid cause code	Destination			
		DTE 80	DTE 84	GW 80	GW 84
DTE 80 (1)	00000000	00000000	00000000	00000000	00000000
DTE 84 (2)	00000000 10000000	00000000 00000000	00000000 10000000	00000000 00000000	00000000 10000000
XI net	0vvvvvvv	0vvvvvvv	0vvvvvvv	00000000	1vvvvvvv
GW 80 (3)	00000000 0vvvvvvv	00000000 0vvvvvvv	00000000 0vvvvvvv	00000000 00000000	00000000 1vvvvvvv
GW 84	00000000 0vvvvvvv 1vvvvvvv 1nnnnnnn	00000000 0vvvvvvv 0vvvvvvv 0nnnnnnn	00000000 0vvvvvvv 1vvvvvvv 1nnnnnnn	00000000 00000000 00000000 00000000	00000000 1vvvvvvv 1vvvvvvv 1nnnnnnn

(1) In principle, DTEs complying with the 1980 version of X.25 should not issue causes with first bit (bit 8) set to 1. This is not checked by XI.

(2) For compliance with ISO standard 8208.

(3) GW defined as X.25 1980 compatible should not transit cause values with bit 8 set to 1. This is not checked by XI

TABLE 18.1/X.25 (part 2 of 2)

XI Handling of Clearing Causes

Source	CAUSE QUALIFIER = SPECIFIC				
	Valid cause code	Destination			
		DTE 80	DTE 84	GW 80	GW 84
DTE 80 (1)	00000000	00000000	00000000	00000000	00000000
DTE 84 (2)	00000000 10000000	00000000 00000000	00000000 10000000	00000000 00000000	00000000 10000000
XI net	1vvvvvvv	0vvvvvvv	1vvvvvvv	00000000	1vvvvvvv
GW 80 (3)	00000000 0vvvvvvv	00000000 0vvvvvvv	00000000 0vvvvvvv	00000000 00000000	00000000 1vvvvvvv
GW 84	00000000 0vvvvvvv 1vvvvvvv 1nnnnnnn	00000000 0vvvvvvv 0vvvvvvv 0nnnnnnn	00000000 0vvvvvvv 1vvvvvvv 1nnnnnnn	00000000 00000000 00000000 00000000	00000000 1vvvvvvv 1vvvvvvv 1nnnnnnn

(1), (2), (3) Same as above.

5.2.3.1.2 Diagnostic Code

Octet 5 is the diagnostic code and contains additional information on the reason for the clearing of the call.

In a clear request packet, the diagnostic code is not mandatory.

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 all be zero.

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 all zeros 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. Annex E 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. Unspecified code combinations in the diagnostic code field shall not cause the DTE to refuse the cause field.

5.2.3.2 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 ss. 6 and 7. 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.

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.

The extended format can be used by the DTE, with the call transfer selection facility included, to transfer a virtual call to another DTE. If the call transfer selection facility is not present, the clearing procedure is completed as with the basic format.

5.2.3.2.1 Address Length Fields

Octet 6 consists 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 address length indicator is binary coded and bit 1 or 5 is the low order bit of the indicator.

5.2.3.2.2 Address Field

When present, octet 7 and the following octets consist of the called DTE address when present, then the calling DTE address when present.

Each digit of an address is coded in a semi-octet 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 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.

5.2.3.2.3 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.

5.2.3.2.4 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 ss. 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.

If the call transfer selection facility is present, then the virtual call is transferred to the address included in the facility (alternate DTE address). CCITT-defined facilities included by the clearing DTE are transferred to the alternate DTE. Non X.25 facilities in the network of the alternate DTE are also transferred. Both types of facilities are delivered to the alternate DTE in the Facility Field of the incoming call packet resulting from the transfer. XI does not accept other X.25 facilities in the clear request packet in extended format. If any are present, the virtual call is simply cleared, and no transfer occur.

If the call transfer selection facility is not present, all other facilities are ignored.

5.2.3.2.5 Clear User Data Field

This field may be present. If present, it is limited to 16 octets, and must contain an integral number of octets.

If the call transfer selection facility is present, then the Clear User Data Field is transferred to the alternate DTE, in the incoming call packet resulting from the transfer.

If the call transfer selection is not present, the clear request packet is rejected by a clear indication packet, with a cause "Local procedure error" and a diagnostic "Packet too long".

When a virtual call has been established or is being cleared between two packets mode DTEs, the network does not act on any part of the clear user data field. See Recommendation X.244.

5.2.4 DTE and DCE Clear Confirmation Packets

Figure 5/X.25 illustrates the format of the DTE and DCE clear confirmation packets, in the basic or extended 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 packet.

Octets	Bits 8	7	6	5	4	3	2	1	
1	General format identifier (see Note)				Logical channel group number				
2	Logical channel number								
3	Packet type identifier								
	0	0	0	1	0	1	1	1	
4	Calling DTE address length				Called DTE address length				(a)
5	DTE address(es)								(a)
	Facility length								(a)
	Facilities								(a)

(a) Used only in the extended format of DCE clear confirmation packets.

Note - Coded 0001 (modulo 8) or 0010 (modulo 128).

FIGURE 5/X.25

DTE and DCE clear confirmation packet format

XI does not include the charging information facility, thus the extended format for the DCE clear confirmation packet is not used: X.25 5.2.4.1 to 5.2.4.4 are therefore not applicable in the XI environment.

5.3 DATA AND INTERRUPT PACKETS

5.3.1 DTE and DCE Data Packets

Figure 6/X.25 illustrates the format of the DTE and DCE data packets.

Octets	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1
1	General format identifier: Q	D	0	1	Logical channel group number			
2	Logical channel number							
3	P(R)			M	P(S)			0
:	User data							

(Modulo 8)

Octets	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1
1	General format identifier: Q	D	1	0	Logical channel group number			
2	Logical channel number							
3	P(S)							0
4	P(R)							M
:	User data							

(When extended to modulo 128)

D Delivery confirmation bit
M More data bit
Q Qualifier bit

FIGURE 6/X.25

DTE and DCE Data Packet Format

5.3.1.1 Qualifier (Q) Bit

Bit 8 of octet 1 is the qualifier (Q) bit.

5.3.1.2 Delivery Confirmation (D) Bit

Bit 7 of octet 1 is the delivery confirmation (D) bit.

5.3.1.3 Packet Receive Sequence Number

Bits 8, 7 and 6 of octet 3, or bits 8 through 2 of octet 4 when extended, are used to indicate the packet receive sequence number P(R). P(R) is binary coded and bit 6, or bit 2 when extended, is the low order bit.

5.3.1.4 More Data Bit

Bit 5 in octet 3, or bit 1 in octet 4 when extended, is used for the more data mark (M bit): 0 for no more data and 1 for more data.

5.3.1.5 Packet Send Sequence Number

Bits 4, 3 and 2 of octet 3, or bits 8 through 2 of octet 3 when extended, are used to indicate the packet send sequence number P(S). P(S) 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: XI networks require the user data field to contain an integral number of octets.

5.3.2 DTE and DCE Interrupt Packets

Figure 7/X.25 illustrates the format of the DTE and DCE interrupt packets.

Bits

Octets	8	7	6	5	4	3	2	1
1	General format identifier (see Note)				Logical channel group number			
2	Logical channel number							
3	Packet type identifier							
	0	0	1	0	0	0	1	1
4	Interrupt user data							

Note - Coded 0001 (modulo 8) or 0010 (modulo 128).

FIGURE 7/X.25

DTE and DCE Interrupt Packet Format

5.3.2.1 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 - XI networks require the interrupt user data field to contain an integral number of octets.

5.3.3 DTE and DCE Interrupt Confirmation Packets

Figure 8/X.25 illustrates the format of the DTE and DCE interrupt confirmation packets.

Bits

Octets	8	7	6	5	4	3	2	1
1	General format identifier (see Note)				Logical channel group number			
2	Logical channel number							
3	Packet type identifier							
	0	0	1	0	0	1	1	1

<u>Note</u> - Coded 0001 (modulo 8) or 0010 (modulo 128).

FIGURE 8/X.25

<u>DTE and DCE interrupt confirmation packet format</u>

5.4 FLOW CONTROL AND RESET PACKETS

5.4.1 DTE and DCE Receive Ready (RR) Packets

Figure 9/X.25 illustrates the format of the DTE and DCE RR packets.

Bits

Octets	8	7	6	5	4	3	2	1
1	General format identifier				Logical channel group number			
	0	0	0	1				
2	Logical channel number							
3	P(R)			Packet type identifier				
				0	0	0	0	1

(Modulo 8)

Bits

Octets	8	7	6	5	4	3	2	1
1	General format identifier				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	P(R)							0

(When extended to modulo 128)

FIGURE 9/X.25

DTE and DCE RR Packet Format

5.4.1.1 Packet Receive Sequence Number

Bits 8, 7 and 6 of octet 3, or bits 8 through 2 of octet 4 when extended, are used to indicate the packet receive sequence number P(R). P(R) is binary and bit 6, or bit 2 when extended, is the low order bit.

5.4.2 DTE and DCE Receive Not Ready (RNR) Packets

Figure 10/X.25 illustrates the format of the DTE and DCE RNR packets.

Bits

Octets	8	7	6	5	4	3	2	1
1	General format identifier 0	0	0	1	Logical channel group number			
2	Logical channel number							
3	P(R)			Packet type identifier 0	0	1	0	1

(Modulo 8)

Bits

Octets	8	7	6	5	4	3	2	1
1	General format identifier 0	0	1	0	Logical channel group number			
2	Logical channel number							
3	Packet type identifier 0	0	0	0	0	1	0	1
4	P(R)							0

(When extended to modulo 128)

FIGURE 10/X.25

DTE and DCE RNR Packet Format

5.4.2.1 Packet Receive Sequence Number

Bits 8, 7 and 6 of octet 3, or bits 8 through 2 of octet 4 when extended, are used to indicate the packet receive sequence number P(R). P(R) 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 11/X.25 illustrates the format of the reset request and reset indication packets.

Octets	Bits 8	7	6	5	4	3	2	1
1	General format identifier (see Note)				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(a)							

(a) This field is not mandatory in reset request packets.

Note: Coded 0001 (modulo 8) or 0010 (modulo 128).

FIGURE 11/X.25

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 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
```

See the note below Table 19/X.25 for the values permitted to a DTE attached to an XI node.

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 Annex C.

XI considers a not-permitted cause field issued by a DTE as an error and will take the actions described in Annex C.

The coding of the resetting cause field in a reset indication packet is given in Table 19/X.25.

TABLE 19/X.25

Coding of Resetting Cause Field in Reset Indication Packet

	Bits
	8 7 6 5 4 3 2 1
DTE originated	0 0 0 0 0 0 0 0
DTE originated(a)	1 X X X X X X X
Out of order(b)	0 0 0 0 0 0 0 1
Remote procedure error	0 0 0 0 0 0 1 1
Local procedure error	0 0 0 0 0 1 0 1
Network congestion	0 0 0 0 0 1 1 1
Remote DTE operational(b)	0 0 0 0 1 0 0 1
Network operational(b)	0 0 0 0 1 1 1 1
Incompatible destination	0 0 0 1 0 0 0 1
Network out of order(b)	0 0 0 1 1 1 0 1

a. When bit 8 is set to 1, the bits represented by Xs are those indicated by the remote DTE in the resetting cause field (virtual calls and permanent virtual circuits) or the restarting cause field (permanent virtual circuits only) of the reset or restart request packet respectively.
Table 19.1/X.25 describes the different resetting cause values accepted or generated by XI, or generated by DTEs, in restart request packets, and delivered on PVCs.

b. Applicable to permanent virtual circuits only.

The cause codes generated by a DCE in an XI node are controlled by a cause qualifier parameter. This parameter is chosen by the network provider to be either 'standard' or 'specific':

- When the cause qualifier parameter value is "standard", and the DTE has subscribed to the 1984 version of X.25, the values of the cause field sent for a DTE should be selected from Table 19/X.25. The values which may be sent to DTEs attached to the XI network are those in Table 19/X.25, irrespective of the origin of the reset (the XI network or a PSDN connected through a GW-DTE function).

  However, when resets are passed to a PSDN through the GW-DTE function, the bit 8 of the cause is set to 1 so as to comply with the Recommendation, irrespective of the origin of the reset (the DTE on the XI network or the XI network itself), provided the PSDN accepts it (see Table 19.1/X.25).

- When the cause qualifier parameter value is "specific", the values generated by the XI network are those shown in Table 19/X.25 with bit 8 set to 1. Reset codes issued by a PSDN are those shown in Table 19/X.25, and can thus be differentiated from resets issued by the XI network. A DTE attached to the PSDN will also be capable of differentiating the network origin of the reset.

Table 19.1/X.25 summarizes XI handling for various combinations of DTEs, GW-DTE and XI parameters:

Notes:

vvvvvvv is bits 7 to 1 of any cause code explicitly shown in Table 19/X.25
nnnnnnn is any bit value other than vvvvvvv

DTE 80 is a DTE attached to the XI network with parameter "X.25 1980"
DTE 84 is a DTE attached to the XI network with parameter "X.25 1984"

GW 80 is a GW-DTE towards a PSDN based on the 1980 version of X.25
GW 84 is a GW-DTE towards a PSDN based on the 1984 version of X.25.

TABLE 19.1/X.25 (part 1 of 2)

XI handling of resetting causes

	CAUSE QUALIFIER = STANDARD				
Source	Valid cause code	Destination			
		DTE 80	DTE 84	GW 80	GW 84
DTE 80 (1)	00000000	00000000	00000000	00000000	00000000
DTE 84 (2)	00000000 10000000	00000000 00000000	00000000 10000000	00000000 00000000	00000000 10000000
XI net	0vvvvvvv	0vvvvvvv	0vvvvvvv	00000000	1vvvvvvv
GW 80 (3)	00000000 0vvvvvvv	00000000 0vvvvvvv	00000000 0vvvvvvv	00000000 00000000	00000000 1vvvvvvv
GW 84	00000000 0vvvvvvv 1vvvvvvv 1nnnnnnn	00000000 0vvvvvvv 0vvvvvvv 0nnnnnnn	00000000 0vvvvvvv 1vvvvvvv 1nnnnnnn	00000000 00000000 00000000 00000000	00000000 1vvvvvvv 1vvvvvvv 1nnnnnnn

(1) In principle, DTEs complying with the 1980 version of X.25 should not issue causes with first bit (bit 8) set to 1. This is not checked by XI.

(2) For compliance with ISO standard 8208

(3) GW defined as X.25 1980 compatible should not transit cause values with bit 8 set to 1. This is not checked by XI

TABLE 19.1/X.25 (part 2 of 2)

XI handling of resetting causes

	CAUSE QUALIFIER = SPECIFIC				
Source	Valid cause code	Destination			
		DTE 80	DTE 84	GW 80	GW 84
DTE 80 (1)	00000000	00000000	00000000	00000000	00000000
DTE 84 (2)	00000000 10000000	00000000 00000000	00000000 10000000	00000000 00000000	00000000 10000000
XI net	1vvvvvvv	0vvvvvvv	1vvvvvvv	00000000	1vvvvvvv
GW 80 (3)	00000000 0vvvvvvv	00000000 0vvvvvvv	00000000 0vvvvvvv	00000000 00000000	00000000 1vvvvvvv
GW 84	00000000 0vvvvvvv 1vvvvvvv 1nnnnnnn	00000000 0vvvvvvv 0vvvvvvv 0nnnnnnn	00000000 0vvvvvvv 1vvvvvvv 1nnnnnnn	00000000 00000000 00000000 00000000	00000000 1vvvvvvv 1vvvvvvv 1nnnnnnn

(1), (2), (3) Same as above.

5.4.3.2 Diagnostic Code

Octet 5 is the diagnostic code and contains additional information on the reason for the reset.

In a reset request packet the diagnostic code is not mandatory.

In a reset indication packet, if the resetting cause field indicates "DTE originated", the diagnostic code has been passed unchanged from the resetting DTE. 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 all be zeros.

When a reset indication packet results from a restart request packet, the value of the diagnostic code will be that specified in the restart request packet, or all zeros 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 a reset indication packet is network generated. Annex E lists the codings for network generated diagnostics. The bits of the diagnostic code are all set to 0 when no specified 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. Unspecified code combinations in the diagnostic code field shall not cause the DTE to not accept the cause field.

5.4.4 DTE and DCE Reset Confirmation Packets

Figure 12/X.25 illustrates the format of the DTE and DCE reset confirmation packets.

Octets	Bits 8	7	6	5	4	3	2	1
1	General format identifier (see Note)				Logical channel group number			
2	Logical channel number							
3	Packet type identifier: 0	0	0	1	1	1	1	1

Note - Coded 0001 (modulo 8) or 0010 (modulo 128).

FIGURE 12/X.25

DTE and DCE Reset Confirmation Packet Format

5.5 RESTART PACKETS

5.5.1 Restart Request and Restart Indication Packets

Figure 13/X.25 illustrates the format of the restart request and restart indication packets.

Bits

Octets	8	7	6	5	4	3	2	1
1	General format identifier (see Note)				0	0	0	0
2	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(a)							

(a) This field is not mandatory in restart request packets.

<u>Note</u> - Coded 0001 (modulo 8) or 0010 (modulo 128).

FIGURE 13/X.25

<u>Restart Request and Restart Indication Packet Format</u>

5.5.1.1 Restarting Cause Field

Octet 4 is the restarting cause field and contains the reason for the restart.

In <u>restart request</u> 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

See the note below Table 20/X.25 for the values allowed for a DTE attached to an XI node.

The DCE will prevent values of the restarting cause field other than those shown above from reaching the other end of the virtual calls and/or permanent virtual circuits by either accepting the <u>restart request</u> packet and forcing the clearing or resetting cause field to all 0s in the corresponding <u>clear</u> and/or <u>reset indication</u> packets, or considering the restart request as an error and following the procedure described in Annex C.

XI considers a not-permitted cause field issued by a DTE as an error and will take the actions described in Annex C.

The coding of the restarting cause field in the restart indication packets is given in Table 20/X.25.

TABLE 20/X.25

Coding of the Restarting Cause Field in Restart Indication Packet

	Bits 8 7 6 5 4 3 2 1
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 (a)	0 1 1 1 1 1 1 1

(a) May be received only if the optional online facility registration facility is used.

The cause codes generated by a DCE in an XI node are controlled by a cause qualifier parameter. This parameter is chosen by the network provider to be either 'standard' or 'specific':

- When the cause qualifier parameter value is 'standard', and the DTE has subscribed to the 1984 version of X.25, the values of the cause field for a DTE should be selected from Table 20/X.25. The values which may be sent to DTEs attached to the XI network are those in Table 20/X.25.

  However, when clears or resets resulting from the restart are passed to a PSDN through the GW-DTE function, bit 8 of the cause is set to 1 so as to comply with the Recommendation, irrespective of the origin of the restart (the DTE on the XI network or the XI network itself) provided the PSDN accepts it (see Tables 18.1/X.25 and 19.1/X.25).

- When the cause qualifier parameter value is "specific", and the DTE has subscribed to the 1980 version of X.25, the only value permitted to DTEs attached to an XI node is all 0s, (otherwise it is a procedure error). The values generated by the XI network are those shown in Table 20/X.25 with bit 8 set to 1. Restart codes resulting in clears or resets and issued by a PSDN are those shown in Table 20/X.25, and thus can be differentiated from those issued by the XI network. A DTE attached to the PSDN will also be capable of differentiating the network origin of the clear or the reset resulting from a restart. Tables 18.1/X.25 and 19.1/X.25 describe possible cause codes received by remote DTEs following a restart procedure in an XI network.

5.5.1.2 Diagnostic Code

Octet 5 is the diagnostic code and contains additional information on the reason for the restart.

In a restart request packet, the diagnostic code is not mandatory. The diagnostic code, if specified, is passed to the corresponding DTEs as the diagnostic code of a reset indication packet for permanent virtual circuits or a clear indication packet for virtual calls.

The coding of the diagnostic code field in a restart indication packet is given in Annex E. The bits of the diagnostic code are all set to zero 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. 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 14/X.25 illustrates the format of the DTE and DCE restart confirmation packets.

Octets	Bits 8	7	6	5	4	3	2	1
1	General format identifier (see Note)				0	0	0	0
2	0	0	0	0	0	0	0	0
3	Packet type identifier							
	1	1	1	1	1	1	1	1

Note - Coded 0001 (modulo 8) or 0010 (modulo 128).

FIGURE 14/X.25

DTE and DCE restart confirmation packet format

5.6 DIAGNOSTIC PACKET

Figure 15/X.25 illustrates the format of the diagnostic packet.

Octets	Bits 8	7	6	5	4	3	2	1
1	General format identifier (see Note 1)				0	0	0	0
2	0	0	0	0	0	0	0	0
3	Packet type identifier							
	1	1	1	1	0	0	0	1
4	Diagnostic code							
5	Diagnostic explanation (see Note 2)							

Note 1 - Coded 0001 (modulo 8) or 0010 (modulo 128).

Note 2 - The figure is drawn assuming the diagnostic explanation field is an integral number of octets in length.

FIGURE 15/X.25

Diagnostic packet format

| The XI diagnostic explanation field contains always an integral number of octets.

5.6.1 Diagnostic Code Field

Octet 4 is the diagnostic code and contains information on the error condition which resulted in the transmission of the diagnostic packet. The coding of the diagnostic code field is given in Annex E.

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 Table C-1/X.25 and C-2/X.25), 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.

When the diagnostic packet is issued as a result of a DCE time-out (see Table D-1/X.25), the diagnostic explanation field contains 2 octets coded as follows:

- Bits 8, 7, 6 and 5 of the first octet contain the general format identifier for the interface;
- Bits 4 to 1 of the first octet and bits 8 to 1 of the second octet are all 0 for expiration of time-out T10 and give the number 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 packet retransmission facility is not available with XI.

5.7.2 Registration Packets for the Online Facility Registration Facility

The online facility registration facility is not available with XI.

5.8 XI ADDRESS FORMATS

5.8.1 Architectural Considerations

The configuration of an XI network is the responsibility of the network service provider who must decide:

- The XI network addressing scheme, which assigns at least one "home DTE address", to each DTE within that XI network. (Note: In the remainder of this section, the word "address" without a qualifier means the "home DTE address".)
- The length of the address (the number of digits of the home DTE address), which is the same for all DTEs in a network, but may differ from one XI network to another, and must be less than or equal to 10. In an X.25 environment, the digits of an address are BCD encoded and two digits are encoded in one byte in the address field.
- The value for the prefix of the DTE address, which specifies the syntax of the content of the address fields of X.25 packets.

The routing process of XI takes into account two levels of hierarchy:

1. The DTE per XI node (the "DTE number") level, and

2. The XI node per XI network (the "XI node number") level.

The format of an XI address (a "home DTE address") is:

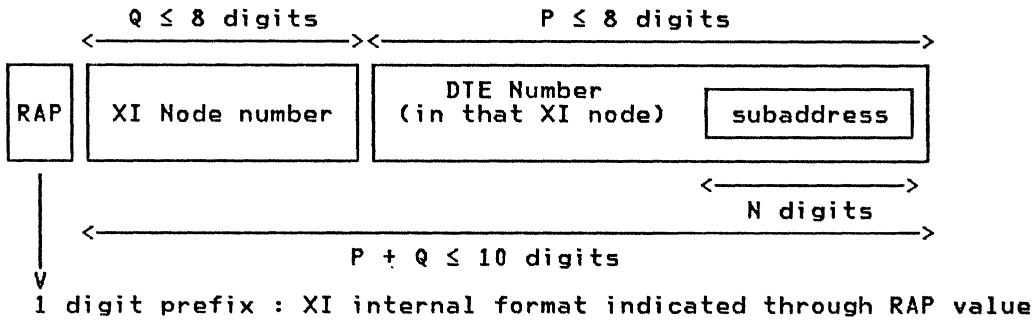


FIGURE 5.8.1/1

<u>Format of the "home DTE address" in an XI network</u>

More than one address can be assigned to a particular DTE. When more than one address is assigned, these addresses must be consecutive; the lowest address (the <u>"generic address"</u>) must be a multiple of 10 exp.N. A subaddress is the difference between the DTE address and the generic address. All subaddresses from 0 to 10 exp.N - 1 are valid.

The calling and called address fields of X.25 packets do not necessarily include the complete "home DTE address" format of DTEs belonging to the addressing scheme of an XI network. For example, calls within the same XI node may omit the XI node number. Communications may also be established with DTEs attached to external X.25 networks, such as public data networks. This is how XI allows non-XI address formats at the interface between a DTE and its XI access node. An XI address format is identified by an <u>XI prefix.</u> The XI prefix is defined as the <u>first digit</u> (the more significant one) in the address field of signalling packets exchanged at the interface between a DTE and its access XI node.

The two different address formats supported by XI are as follows:

1. <u>Internal format, Relative Address Prefix (RAP)</u>

   With this format a portion of the "home DTE address" of a DTE, in the addressing scheme of the XI network, follows the prefix digit. The address digits in the XI addressing scheme are located <u>after</u> the prefix digit in the address field. The address portion may be:

   - A subaddress (only in the calling DTE address field of the <u>call request</u> packet)
   - A "DTE number" within its access XI node
   - A "DTE number" and an "XI node number" within the network addressing scheme, i.e., the complete "home DTE address" itself.

   The value for RAP is chosen by the network service provider. The relative address format is a variable format and permits DTEs to handle a short number of digits in the called DTE address field of call request packets when, for example, the called DTE is located on the same XI node as the calling DTE.

2. <u>External format</u>

   This format is used for virtual calls between a DTE attached to an XI node and a DTE attached to a PSDN (for example, a Public Data Network), when the XI network has one or several GW-DTE connections with that PSDN. Such a format is identified in one of two ways, as described below:

- X.121 address prefix (XAP)

  With this format, the four digits after the prefix are interpreted by XI as the external PSDN identifier (Data Network Identification Code, or DNIC), and the remaining digits as the address of a DTE in the external PSDN addressing plan. Any prefix specific to the external network is not part of the XAP address format. Instead, the GW-DTE function will either replace the XAP by the prefix required by the external PSDN, or will delete it (if no prefix is required by the PSDN).

- Default external address

  If the first digit is neither RAP nor XAP, then XI directs the call towards a default external PSDN: the first digit must then be the first digit which is required for addressing within that PSDN.

  If the default external addressing is used, then the value for RAP/XAP must be selected in the following way:

  - If the XI network is connected with a PSDN making use of specific prefix(es), then eliminate from the choice of RAP/XAP any specific prefix value that has to be used for external calls.

  - If the XI network is connected with a PSDN making use of full X.121 addresses, then eliminate from the choice of RAP/XAP the first digit (area code) of the DNIC of any PSDNs that have to be reached from the XI network as default external network.

  - Select the RAP/XAP values from the remaining values.

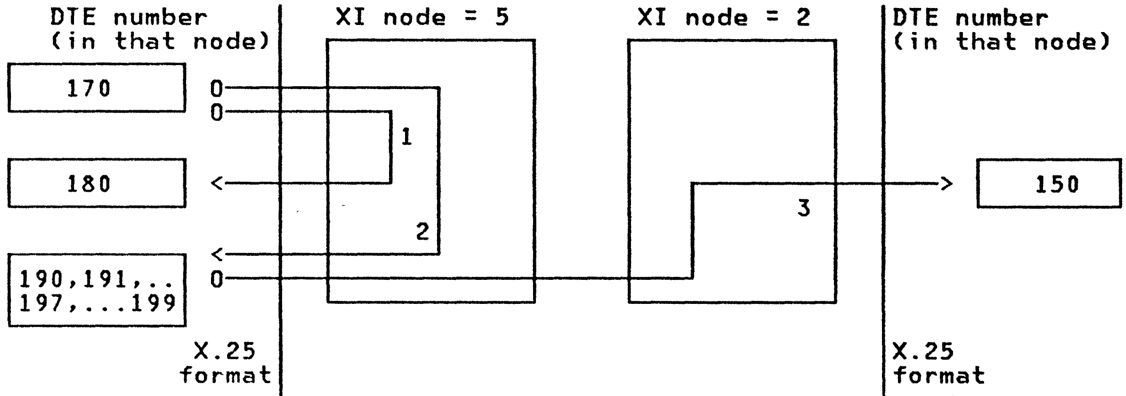
The following sections describe how addresses are handled in an XI network.

5.8.2 Addressing DTEs within an XI Network Using the RAP Format

Figure 5.8.2/1 gives examples of address handling within an XI network.

Example:

- Assuming RAP = 1
- Assuming the addressing scheme of the network is:
  - DTE number length: P = 3,
  - subaddresses/DTE: max = 10 (N = 1)
  - DTEs/XI node: max = 100
  - nodes/network: max = 10 (Q = 1)
- Assuming the addressable elements are:
  - Node = 5 with DTE = 170, 180, 190 to 199 (multiaddress DTE)
  - Node = 2 with DTE = 140, 150.



Call	X.25 format		XI Internal format		X.25 format	
	Called DTE address	Calling DTE address	Called DTE address	Calling DTE address	Called DTE address	Calling DTE address
1	1180	–	15180	15170		
2	1197	–	15197	15170		
3	12150	7	12150	15197	12150	15197

Call 1 A local call within node = 5. The calling DTE (170) gives only the DTE number of the called DTE (180),prefixed by the RAP (1). XI inserts the node number (5).

Call 2 A similar call towards DTE with generic address 190. The subaddress is 7.

Call 3 The calling DTE indicates a subaddress (7) which is added to the generic address (15190 + 7 = 15197).

FIGURE 5.8.2/1

Example of addressing within an XI network

5.8.3 Addressing to and from a PSDN Connected to XI

5.8.3.1 Principle

XI can be connected to PSDNs through its GW-DTE function. When such a connection exist, DTEs attached to XI can originate virtual calls to DTEs attached to the PSDN, and receive virtual calls from DTEs connected to the PSDN.

A PSDN can transit SVCs between two XI networks. Similarly, an XI network can transit SVCs between two PSDNs. However, these capabilities can be barred by the XI network service provider, if, for instance, they conflict with national regulations of the country where the network is operated.

5.8.3.2 Complementary addressing mechanism

A GW-DTE is assigned one X.25 address in the addressing plan of an external PSDN. The DTEs attached to the XI network are not known by this PSDN. Therefore there is a need to use a complementary addressing mechanism to address XI-attached DTEs from PSDN-attached DTEs.

5.8.3.3 XI outbound calls

The fact that the Called DTE is attached to a PSDN ("external DTE") is indicated by the first digit of the Called Address being different from RAP.

If this digit is the XAP, then the routing function in the XI network will select the appropriate GW-DTE from the DNIC included in the Called Address (the 4 digits after the prefix). Before transmitting the Call to the external PSDN, the GW-DTE function of XI replaces the XAP by the prefix required by the external PSDN, and removes the calling DTE address. If the external PSDN requires no prefix, the GW-DTE removes the XAP digit.

If this digit is neither RAP nor XAP, then the routing function in the XI network will select a default GW-DTE.

As the GW-DTE selection is performed by the XI node there is no need for the DTEs attached to the XI network to handle any complementary addressing mechanism.

5.8.3.4 XI inbound calls

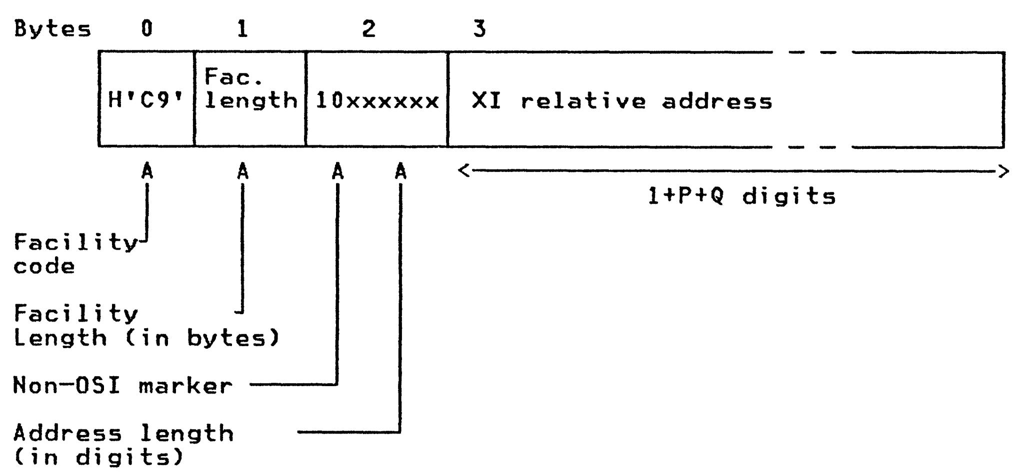
The external DTE will have to handle complementary addressing mechanisms so as to be able to call a DTE attached to an XI network. Three possible mechanisms can be used:

1. <u>Called Address Extension Facility (1984 version of X.25, see Annex G)</u>:

   Two formats of extended address field are accepted by XI.

   The non-OSI format, identical to the XI Programming RPQ format, supported for upward compatibility reasons.

Byte 0	Facility code (Hexadecimal 'C9')	
Byte 1	Facility length (in bytes)	
Byte 2	10xxxxxx	
	10	Non OSI address marker
	xxxxxx	number of digits in the conveyed address
From byte 3	XI address of the called DTE, prefixed by the RAP.	



   The OSI format, which should be preferred

Coding is as follows:

Byte 0 Facility code (Hexadecimal 'C9')

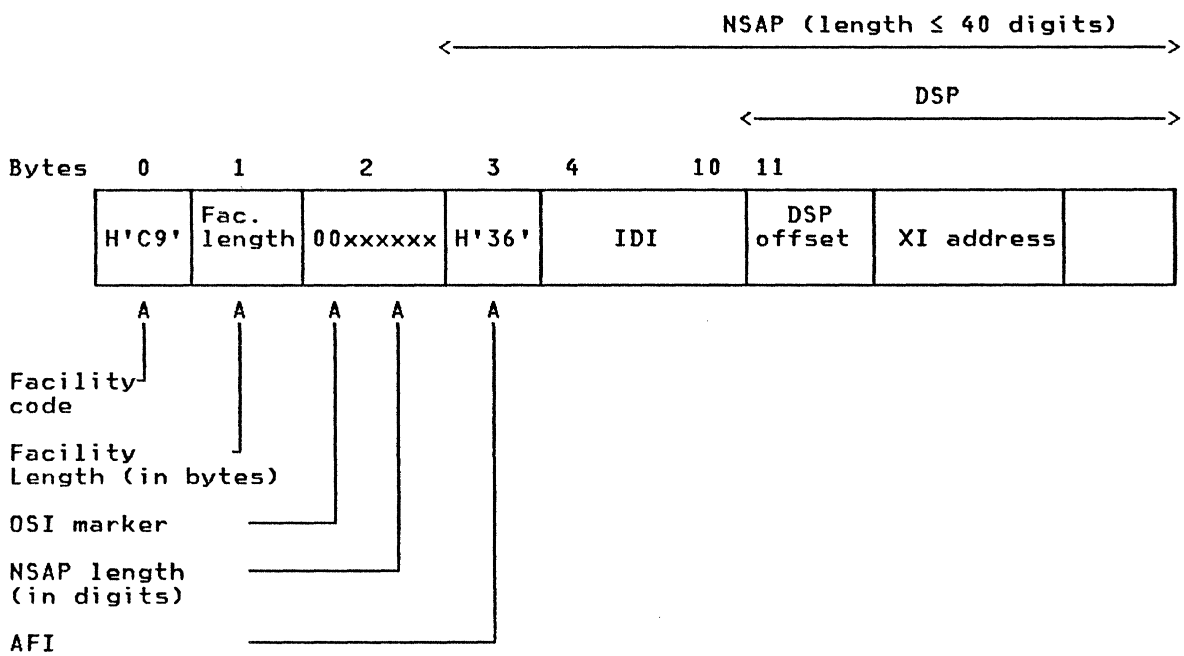
Byte 1 Facility length (in bytes)

Byte 2 00xxxxxx

- **00** OSI address marker
- **xxxxxx** number of digits in the NSAP

From byte 3 NSAP, whose maximum length is 40 digits (BCD), which splits as follows

- **Byte 3** Authority and Format Identifier (AFI): 36 (BCD coded) for CCITT, BCD encoding
- **Byte 4-10** Initial Domain Identifier (IDI): PSDN address of the GW-DTE, right justified, padded with leading zeroes
- **From byte 11** Domain Specific portion (DSP), which in turn splits as follows:
  - **DSP offset** Reserved for compatibility with forthcoming standards on DSP addressing scheme. The length of this offset, in digits (half-bytes), is defined by the network service provider, for the whole XI network.
  - **Address** XI address of the called DTE, prefixed by the RAP (XI DTE, 1+P+Q digits), the XAP (external DTE) or an external PSDN specific prefix (external DTE)



2. Customized use of call user data field (CUDF):

The format chosen for XI permits X.28 DTEs attached to 1980 or 1984 PADs to issue calls requiring complementary addressing. The complementary address is encoded in CUDF, from the fifth byte. Each digit is encoded to comply with international alphabet No. 5 (ASCII) in one byte. The last digit of the complementary address is either the last byte of CUDF or the byte located just before a carriage return or + (plus) character. A constraint is that a complementary address can only have up to 12 digits. Only XI relative address, prefixed by RAP, including the node number and DTE number (1+P+Q digits) can be used in the CUDF.

Note: The use of CUDF is seen as a temporary solution which should preferably be replaced by the use of the extended addressing facilities of the 1984 version of X.25, when available on PSDN. Note that the XI address of a calling DTE will not be sent to a called DTE on a PSDN when the called address extension facility cannot be used (XI never changes the content of CUDF).

3. Default call: This is a default DTE address, installed by the network service provider on the GW-DTE, applicable to all logical channels of this GW-DTE, and used as a called address for all XI inbound calls, when no called address extension facility has been included in the call request packet, and no CUDF or no valid XI address in the CUDF has been found.

Figure 5.8.3/1 summarizes the complementary addressing mechanisms usage by the GW-DTE, for XI inbound calls.

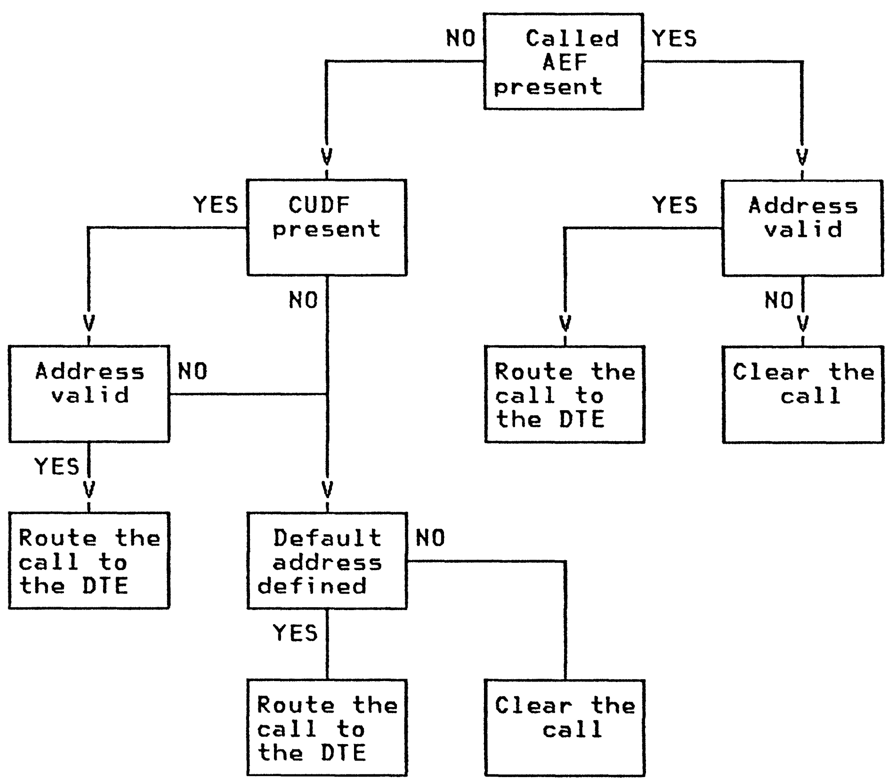


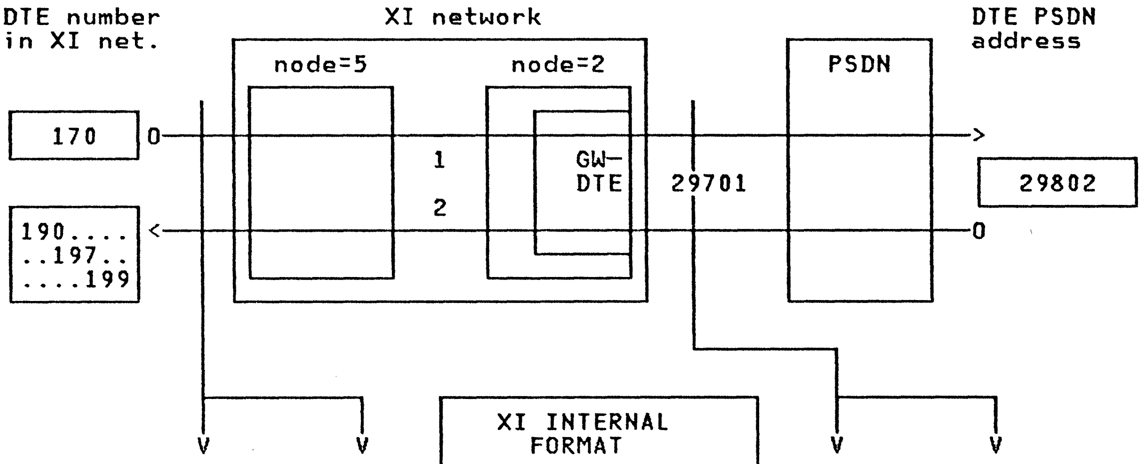
FIGURE 5.8.3/1

Complementary addressing mechanisms

Figure 5.8.3/2 is an example of addressing between an XI network and a PSDN.

Example:

- The same network (as in 5.8.2) is assumed with a GW-DTE function in node=2. This GW-DTE function is attached to a PSDN which makes use of a specific prefix (2). The GW-DTE has a PSDN address 29701 and the DTE attached to PSDN has the address 29802. The DNIC of the PSDN is 2060, the XAP is 3, the RAP is 1.
- With call 1, the calling DTE may optionally include a complementary calling DTE address field, which is delivered to the called DTE
- With call 2, the GW-DTE moves the XI address of the called DTE from the complementary called DTE address field to the called DTE address field. The complementary called DTE address is delivered to the called DTE. The DTE attached to the PSDN selects subaddress 7 of the DTE with generic address = 5190



Call	Called DTE address / complem. called DTE address	Calling DTE address / complem. calling DTE address	Called DTE address / complem. called DTE address	Calling DTE address / complem. calling DTE address	Called DTE address / complem. called DTE address	Calling DTE address / complem. calling DTE address
1	320609802 / –	– / 15170 [2]	320609802 / –	15170 / 15170 [2]	320609802 / –	29701 [1] / 15170 [2]
2	15197 / 15197	39802 / –	15197 / 15197	39802 / –	29701 / 15197	29802 / –

Note 1 – The calling DTE address is not given by the GW-DTE, but inserted by PSDN.

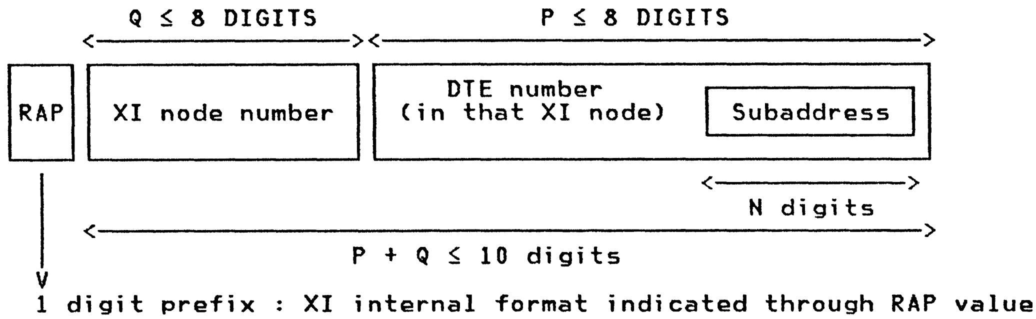
Note 2 – The calling address extension facility is used optionally by the calling DTE, only in the case when such facilities can be used (X.25 1984 parameter).

FIGURE 5.8.3/2

Example of addressing to and from a PSDN

5.8.4 Summary of DTE Address Formats in an XI Network

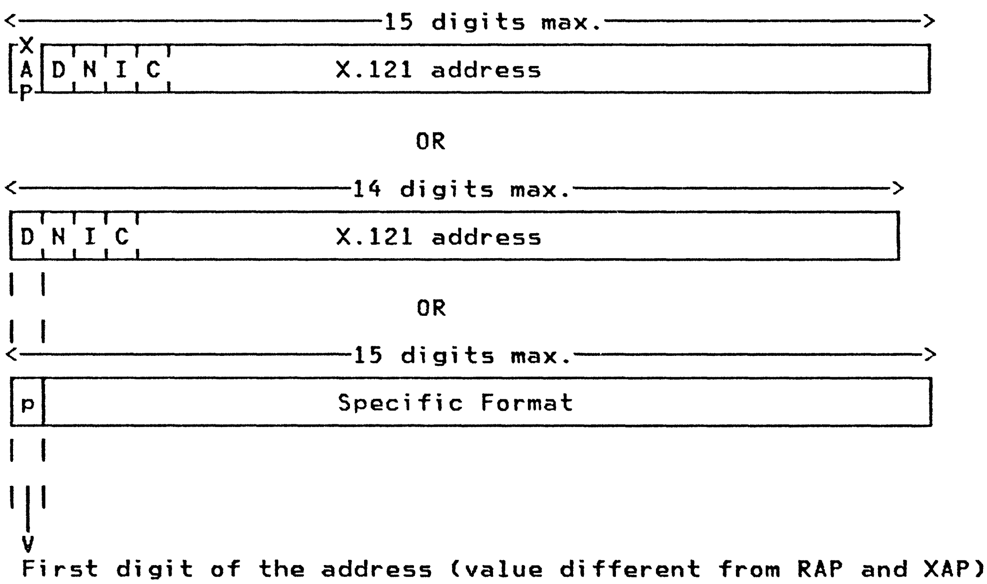
- Addressing within an XI network through prefix RAP



- Abbreviated address formats in call request packets

Calling DTE address:	Called DTE address:
0 digit	-
1 digit = prefix RAP	-
1+N digits	-
1+P digits	1+P digits (local calls only)
1+P+Q digits	1+P+Q digits (remote/local calls)

- Addressing to and from PSDN



5.8.5 Address Handling at the DTE/DCE Interface

Previous sections describe the behaviour of XI nodes in the case of call request and incoming call packets, and which addresses are sent within the XI network. However, XI is designed to offer compatibility with the version 1984 of X.25 which permits address handling in call accepted, call connected, clear request, clear indication, and clear confirmation packets. The XI behaviour in each case where the calling and/or the called DTEs have subscribed to the XI parameter "X.25 1984" or "X.25 1980" is described in 5.8.5.1-6.

5.8.5.1 Call Accepted Packet

The called DTE may or may not insert addresses. The same rules as for the call request packet apply (see 5.8.2 and 5.8.3), plus the following rules:

- The calling DTE address (if present) must be identical to the calling DTE address in the incoming call packet. Its format may be changed to one of the permitted formats shown in 5.8.4.
- The called DTE address (if present) must be identical to the called DTE address in the incoming call packet when the called DTE is only assigned a single address (no subaddressing). If there is subaddressing, the called DTE can change the subaddress field to any value.

5.8.5.2 Call Connected Packet

The call connected packet contains the calling and called DTE addresses. (If there is subaddressing, the called DTE can change the generic address to one of the addresses of the DTE.)

5.8.5.3 Clear Request Packet

The clearing DTE may or may not insert addresses. The same rules as for the call request packet apply (see 5.8.2 and 5.8.3), plus the following rules:

- The calling DTE address (if present) must be identical to the calling DTE address in the incoming call packet. The clearing DTE may change its format to one of the permitted formats shown in 5.8.4.
- The called DTE address (if present) must be identical to the called DTE address in the incoming call packet when the called DTE is only assigned a single address (no subaddressing). If there is subaddressing, the called DTE can change the subaddress field to any value.

The validity of the addresses are not checked by XI.

5.8.5.4 Clear Indication Packet

If the clear indication extended format is used by the DCE, i.e if the DTE is X.25 1984 compatible and facilities are to be delivered to this DTE, then the <u>clear indication</u> packet contains the calling and called DTE addresses, as for the <u>call connected</u> packet.

5.8.5.5 DCE Clear Confirmation

As the charging information facility is not available with XI, the DCE clear confirmation packet does not include any address.

5.8.5.6 DTE Clear Confirmation

X.25 (and XI) does not allow addresses in the DTE clear confirmation packet.

5.9 COMPATIBILITY BETWEEN 1980 AND 1984 VERSIONS OF X.25

The formats of packets at the DTE/DCE interface are basically those of the X.25 Recommendation, 1984 version. XI also supports the DTEs based on the 1980 version of the Recommendation, by means of a subscription parameter (X.25 version 1980 or 1984).

When a DTE subscribes to the 1980 version of X.25, the DCE will issue packets only in the 1980 format; therefore new facilities which require new formats are not passed to the DTE. The design of new facilities in X.25 is, in principle, such that an "old" DTE can continue to be operated without being aware of the content of these facilities.

The differences in packet formats between the 1980 version and the 1984 version of Recommendation X.25 are listed in Annex H. The following describes how XI acts upon DTEs based on the 1984 version of X.25 and those based on the 1980 version.

- The data field of the interrupt packet may be up to 32 bytes with the X.25 1984 version, whereas it is limited to one byte in the 1980 version. In the case where a DTE, which has subscribed to the 1984 version, tries to send an interrupt packet with a data field larger than one byte towards a DTE which has subscribed to the 1980 version, this interrupt packet is delivered.
- If a "1984 DTE" tries to call a "1980 DTE" with 1984 CCITT-specified DTE facilities in the facilities field, the call is delivered to the called DTE.
- The size of the facility field in incoming call and call connected packets will not be greater than 63 octets for "1980 DTEs"

6. PROCEDURES FOR OPTIONAL USER FACILITIES (PACKET LEVEL)

6.1 ONLINE FACILITY REGISTRATION

| The online facility registration facility is not applicable in the XI environment.

6.2 EXTENDED PACKET SEQUENCE NUMBERING

Extended packet sequence numbering is an optional user facility agreed for a period of time. It is common to all logical channels at the DTE/DCE 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

| The D bit modification facility is not applicable in the XI environment.

6.4 PACKET RETRANSMISSION

| The packet retransmission facility is not applicable in the XI environment.

6.5 INCOMING CALLS BARRED

Incoming calls barred is an optional user facility agreed for a period of time. This facility applies to all logical channels used at the DTE/DCE interface 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.

| It is the responsibility of the network service provider to check that the subscription to this facility by a DTE is consistent with the definition of the ranges of logical channels at the DTE/DCE interface.

Note 1 - Logical channels used for virtual calls retain their full duplex capability.

| Note 2 - XI does not allow a virtual call to be sent to the DTE when the called address is the address of the calling DTE.

6.6 OUTGOING CALLS BARRED

Outgoing calls barred is an optional user facility agreed for a period of time. This facility applies to all logical channels used at the DTE/DCE interface for virtual calls.

This user facility, if subscribed to, prevents the DCE from accepting outgoing virtual calls from the DTE. The DTE may receive incoming virtual calls.

It is the responsibility of the network service provider to check that the subscription to this facility by a DTE is consistent with the definition of the ranges of logical channels at the DTE/DCE interface.

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 for a period of time. 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 given in Annex A.

Note - If all the logical channels for virtual calls are one-way outgoing at a DTE/DCE interface, the effect is equivalent to the incoming calls barred facility (see s. 6.5, particularly Note 2).

6.8 ONE-WAY LOGICAL CHANNEL INCOMING

One-way logical channel incoming is an optional user facility agreed for a period of time. This user facility, if subscribed to, restricts the logical channel use to receiving incoming 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 incoming logical channels for virtual calls are given in Annex A.

Note - If all the logical channels for virtual calls are one-way incoming at a DTE/DCE 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 for a period of time. 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 the packet sizes to be the same for each direction of data transmission across the DTE/DCE interface. In the absence of this facility, the default packet sizes are 128 octets.

XI does not constrain packet sizes to be the same 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.

Values other than the default packet sizes may be negotiated for a virtual call by means of the flow control parameter negotiation facility (see 6.12). 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 for a period of time. This 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 interface. In the absence of this facility, the default window sizes are 2.

XI does not constrain window sizes to be the same for each direction of data transmission.

Values other than the default window sizes may be negotiated for a virtual call by means of the flow control parameter negotiation facility (see 6.12). Values other than the default window sizes may be agreed 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 for a period of time. This 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) but do 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 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 for a period of time for each permanent virtual circuit.

XI requires that default throughput classes, if explicitly subscribed to, be lower than or equal to the user class of service (the DTE access link speed).

XI does not constrain throughput classes to be the same for each direction of data transmission.

The maximum throughput class supported by an XI network depends upon the network configuration and is the responsibility of the network service provider.

6.12 FLOW CONTROL PARAMETER NEGOTIATION

Flow control parameter negotiation is an optional user facility agreed 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 flow control parameters. The flow control parameters considered are the packet and window sizes at the DTE/DCE 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 request 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 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 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 will indicate the packet and window sizes from which DTE negotiation can start. 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.

In the case where the incoming call packet indicates the flow control parameters negotiation facility, XI will indicate to the DTE values for packet sizes and window sizes as follows :

- The packet sizes indicated to the called DTE will be the packet sizes selected by the calling DTE, if any, or the default packet sizes of the calling DTE.

- The window sizes indicated to the called DTE will be the default window sizes of the called DTE.

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/X.25. 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.

TABLE 22/X.25

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)

When the calling DTE has subscribed to the flow control parameter negotiation facility, every call connected packet will indicate the packet and window sizes to be used at the DTE/DCE interface for the call. 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/X.25.

TABLE 23/X.25

Valid Facility Indications in Call Accepted Packets in Response to Facility Requests 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; that is, the ranges of parameter values available on various networks may differ.

In the case where the call connected packet indicates the flow control parameters negotiation facility, XI indicates to the DTE values for packet sizes and window sizes chosen as follows:

- The packet sizes indicated to the calling DTE will be the packet sizes negotiated with the called DTE, if any, or the default packet sizes of the called DTE if they comply with the rules depicted in Table 23/X.25, or otherwise the packet sizes selected by the calling DTE.
- The window sizes indicated to the calling DTE will be the window sizes requested by the calling DTE, if any, or the default window sizes of the calling DTE.

XI policy in flow control parameters negotiation is to try to get the same packet sizes at both ends. When the default packet sizes of the calling and the called DTEs are not identical, this can be achieved if at least one of the calling or called DTEs has subscribed to the flow control parameters negotiation facility. Moreover, if only the called DTE has subscribed to the flow control parameters negotiation facility, the equality of packet sizes at both ends requires that the called DTE accepts the values proposed by the network; if only the calling DTE has subscribed to the flow control parameters negotiation facility, the equality of packet sizes at both ends requires that the called DTE default packet sizes be identical or closer to the standard (128) than the default packet sizes requested by the calling DTE or, in the absence of such a request, than the calling DTE default packet sizes. This situation, where packet sizes are the same at both the calling and called DTE avoids packets blocking/segmenting and thereby improves performance.

In the case where flow control parameters negotiation is subscribed, the default window sizes are taken as the basis for negotiation by the DCE. The default window sizes should be chosen with the different criteria when flow control parameters negotiation is subscribed than when it is not subscribed.

Window and packet sizes need not be the same at each end of a virtual call.

6.13 THROUGHPUT CLASS NEGOTIATION

Throughput class negotiation facility is not applicable in the XI 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, that is, for international service.

Note 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.

Note 2 - Users are cautioned that the choice of too small a window and packet size of a DTE/DCE interface (made by use of the flow control parameter negotiation facility) may adversely affect the attainable throughput class of a virtual call. This is likewise true of flow control mechanisms adopted by the DTE to control data transmission from the DCE.

6.14 CLOSED USER GROUP RELATED FACILITIES

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 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.

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. In an XI network, a DTE may subscribe to up to 100 CUGs (0 to 99).

6.14.1 Closed User Group

Closed user group is an optional user facility agreed 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. In an XI network, a DTE may subscribe to up to 100 CUGs (0 to 99).

6.14.2 Closed User Group with Outgoing Access

Closed user group with outgoing access is an optional user facility agreed 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 (that is, 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 (that is, 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.

6.14.3 Closed User Group with Incoming Access

Closed user group with incoming access is an optional user facility agreed 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 (that is, 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 (that is, the closed user group with outgoing access selection 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

Incoming calls barred within a closed user group is an optional user facility agreed 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 DTEs in this closed user group.

6.14.5 Outgoing Calls Barred Within a Closed User Group

Outgoing calls barred within a closed user group is an optional user facility agreed 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

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 DTE belongs to 100 or fewer closed user groups, the basic format of the closed user group selection facility must be used. If the DTE belongs to between 101 and 10000 closed user groups, the extended format of the closed user group selection facility must be used.

As XI permits a DTE to belong to up to 100 closed user groups, only the basic format is used by the DCE, and is to be used by the DTE.

The appearance in a call request packet of both formats or of a format inconsistent with the number of CUGs subscribed to will be treated as a facility code not allowed.

The significance of the closed user group selection facility in call request packets is given in Table 24/X.25 and in incoming call packets is given in Table 25/X.25.

6.14.7 Closed User Group with Outgoing Access Selection

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 DTE belongs to 100 or fewer closed user groups, the basic format of the closed user group with outgoing access selection facility must be used. If the DTE belongs to between 101 and 10 000 closed user groups, the extended format of the closed user group with outgoing access selection facility must be used.

As XI permits a DTE to belong to up to 100 closed user groups, only the basic format is used by the DCE, and is to be used by the DTE.

The appearance in a call request packet of both formats or of a format inconsistent with the number of CUGs subscribed to will be treated as a facility code not allowed.

The significance of the presence of the closed user group with outgoing access selection facility in call request packets is given in Table 24/X.25 and in incoming call packets is given in Table 25/X.25.

6.14.8 Absence of Both CUG Selection Facilities

The significance of the absence of both the closed user group selection facility and the closed user group with outgoing access selection facility in call request packets is given in Table 24/X.25 and in incoming call packets is given in Table 25/X.25.

TABLE 24/X.25

Meaning of Closed User Group Facilities in a Call Request Packet

<table>
<tr><td>Contents of call request packet (see Note 2) —>

Closed user group subscription of the calling DTE | (see Note 1) V</td><td>Closed user group selection facility</td><td>Closed user group with outgoing access selection facility</td><td>Neither closed user group selection nor closed user group with outgoing access selection facility</td></tr>
<tr><td>CUG with preferential (see Note 3)</td><td rowspan="2">CUG specified (see Note 4)</td><td rowspan="4">Not allowed (call cleared)</td><td>Preferential or only CUG (see Note 4)</td></tr>
<tr><td>CUG/IA with preferential</td><td rowspan="2">Preferential or only CUG + outgoing access (see Notes 5, 6)</td></tr>
<tr><td>CUG/OA with preferential</td><td rowspan="2">CUG specified + outgoing access (see Note 4)</td></tr>
<tr><td>CUG/IA/OA with preferential</td><td>Not allowed (call cleared)</td></tr>
<tr><td>CUG/IA without preferential</td><td rowspan="3">CUG specified (see Note 4)</td><td rowspan="3">CUG specified + outgoing access (see Notes 5, 6)</td><td rowspan="4">Outgoing access</td></tr>
<tr><td>CUG/OA without preferential</td></tr>
<tr><td>CUG/IA/OA without preferential</td></tr>
<tr><td>No CUG</td><td>Not allowed (call cleared)</td><td>Not allowed (call cleared)</td></tr>
</table>

OA: Outgoing access
IA: Incoming access

Note 1 - The order of subscription types is different from Table 25/X.25.
Note 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.
Note 3 - CUG without preferential is not allowed.
Note 4 - If outgoing calls are barred within the specified CUG or within the preferential or only CUG, then the call is cleared.
Note 5 - If outgoing calls are barred within the specified CUG or within the preferential or only CUG, then only outgoing access applies.
Note 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 25/X.25

Meaning of Closed User Group Facilities in Incoming Call Packets

Contents of incoming call packet ⟶ / Closed user group subscription of the called DTE (see Note 1) ↓	Closed user group selection facility	Closed user group with outgoing access selection facility	Neither closed user group selection nor closed user group with outgoing access selection facility
CUG with preferential (see Note 2)	CUG specified (see Note 3)	Not applicable	Preferential or only CUG (see Note 3)
CUG/OA with preferential			Preferential or only CUG + incoming access (see Note 5)
CUG/IA with preferential	CUG specified + incoming access (see Note 4)		
CUG/IA/OA with preferential			Not applicable
CUG/OA without preferential	CUG specified (see Note 3)	CUG specified + incoming access (see Note 4)	Incoming access
CUG/IA without preferential			
CUG/IA/OA without preferential			
No CUG	Not applicable	Not applicable	

OA: Outgoing access
IA: Incoming access

Note 1 - The order of subscription types is different from Table 24/X.25.

Note 2 - CUG without preferential is not allowed.

Note 3 - When incoming calls are barred within this CUG, the call is blocked; there is no incoming call.

Note 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.

Note 5 - When incoming calls are barred within this CUG, only incoming access applies.

6.15 BILATERAL CLOSED USER GROUP RELATED FACILITIES

| The bilateral closed user group facility is not applicable in the XI environment.

6.16 FAST SELECT

| The fast select facility is not applicable in the XI environment.

6.17 FAST SELECT ACCEPTANCE

| The fast select acceptance facility is not applicable in the XI environment.

6.18 REVERSE CHARGING

Reverse charging is an optional user facility which may be requested by a DTE for a given virtual call (see 7.2.1 and 7.2.2.6).

6.19 REVERSE CHARGING ACCEPTANCE

Reverse charging acceptance is an optional user facility agreed for a period of time for virtual calls. This user facility, if subscribed to, authorizes the DCE to transmit to the DTE incoming calls which request the reverse charging facility. In the absence of this facility, the DCE will not transmit to the DTE incoming calls which request the reverse charging facility.

6.20 LOCAL CHARGING PREVENTION

| The local charging prevention facility is not applicable in the XI environment.

6.21 NETWORK USER IDENTIFICATION

| The network user identification facility is not applicable in the XI environment.

6.22 CHARGING INFORMATION

| The charging information facility is not applicable in the XI environment.

6.23 RPOA SELECTION

The RPOA selection facility is not applicable in the XI environment.

6.24 HUNT GROUP

The hunt group facility is not applicable in the XI environment.

6.25 CALL REDIRECTION

Call redirection is an optional user facility agreed for a period of time. This user facility, if subscribed to, redirects incoming calls destined to this DTE when:

1. The DTE is out of order, or
2. The DTE is busy.

   Some networks may provide call redirection only in case of 1. Some networks may offer, in addition:

3. Systematic call redirection due to a prior request by the subscriber.

The basic service is limited to one call redirection. In addition, some networks may offer either one of the following (mutually exclusive) capabilities:

1. A list of alternate DTEs (C1, C2, etc.) 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;
2. 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.

In any case, 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/X.25).

If a call is cleared by the network as a consequence of the redirection actions, the clearing cause is in principle the one generated at the last reached DTE/DCE interface. However, this point requires further study.

Call redirection is limited to the network of the DTE originally called.

When the virtual call is redirected, the clear indication packet (when no call accepted packet has been transmitted) or the call connected packet transferred to the calling DTE will contain the called address of the alternate 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, some networks may indicate to the alternate DTE that the call was redirected, the reason for redirection and the address of the originally called DTE, using the call redirection notification facility (see 6.27) in the incoming call packet.

The order of call set-up processing at the originally called DCE as well as the alternate DCE will be according to the sequence of call progress signals in Table 1/X.96. For those networks that provide systematic call redirection with the prior request of the called DTE, the systematic call redirection request will have the highest priority in the call set-up processing sequence at the originally called DCE.

It is for further study whether there is a need for an optional user facility for the calling DTE to indicate whether or not a redirection of a call originated by this DTE is permitted.

XI supports the 3 possible causes of redirection, that is, DTE busy, DTE out-of-order, systematic redirection. Only one alternate DTE can be defined for the originally called DTE. The maximum number of chained redirections is defined by the network service provider. The call redirection facility can be subscribed for an X.25 1980 or X.25 1984 compatible DTE. The called line address modified notification facility and call redirection notification facility are delivered only to X.25 1984 compatible DTEs.

When using the basic call redirection, the called address delivered to the final DTE is the final DTE address (not the absent DTE address).

6.25.1 Call redirection in association with SNBU

The call redirection facility may be used in SNBU situations to facilitate DTE operations, by permitting a DTE temporarily attached to a back-up port through a switched connection, to be accessed with **the same address as for normal operation** from other DTEs. The call redirection remains optional for SNBU.

The SNBU call redirection exhibits the following differences from the basic call redirection:

- The absent DTE is the DTE which is to be secured through the port (i.e. through the DCE occurrence) relative to the final DTE
- If a call is redirected towards a DCE working in SNBU mode, no more redirections are permitted from that DCE, even if the subscription parameters indicate such a possibility and if the maximum number of redirections is not reached.
- The redirection is installed by the network operator on the absent DTE port at the time the failing leased access line is to be temporarily replaced by the switched connection
- The absent DTE address will be delivered in the called address field of the incoming call packet, to the alternate DTE.
- The alternate DCE will accept in the call accepted packet a called address equal to the address of the absent DTE
- The called line address modified notification facility will be delivered to the calling DTE in the call connected packet, if is is subscribed as an X.25 1984 compatible DTE.
- The alternate DTE address will be delivered to the calling DTE in the called address field of the call connected packet

The Call redirection in association with SNBU has priority over other reasons for redirection (systematic, out of order, busy).

6.26 CALLED LINE ADDRESS MODIFIED NOTIFICATION

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 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:

1. The DCE will clear the call if the called address is not one of those applying to the interface.
2. If call redirection has taken place in the public data network, the DCE will replace the reason contained in the called line address modified notification facility with the reason reflecting the status of the originally called DTE; otherwise, the reason is passed transparently.

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.

XI permits modification of the subaddress of the called DTE in the call accepted packet, without the need to use the called line address modified notification facility.

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:

1. Call distribution within a Hunt Group (not applicable to XI)
2. Call redirection due to originally called DTE out of order
3. Call redirection due to originally called DTE busy
4. Call redirection due to prior request from the originally called DTE for systematic call redirection
5. DTE originated (only in case of call transfer)

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 "DTE originated".

XI does not accept the called line address modified notification facility to be included by the DTE in call accepted or clear request packets, and clears the call in this case, with cause "Invalid facility request" and diagnostic "Facility code not allowed". XI delivers this facility to the calling DTE only if it is subscribed as an X.25 1984 compatible DTE.

6.27 CALL REDIRECTION NOTIFICATION

Call redirection notification is a user facility used by the DCE in the incoming call packet to inform the alternate DTE that the call has been redirected, why the call was redirected, and the address of the originally called DTE.

The following reasons can be indicated with the use of the call redirection notification facility (see 7.2.1 and 7.2.2.11):

1. Call redirection due to originally called DTE out of order
2. Call redirection due to originally called DTE busy
3. Call redirection due to prior request from the originally called DTE for systematic call redirection.

XI delivers the call redirection notification facility to the alternate DTE only if it is subscribed as an X.25 1984 compatible DTE, and if the basic (not SNBU) call redirection is being used.

6.28 TRANSIT DELAY SELECTION AND INDICATION

The transit delay selection and indication facility is not applicable in the XI environment.

6.29 CALL TRANSFER

Call Transfer is an optional user facility, **specific to XI**, which allows the originally called DTE to forward individual incoming virtual calls, after reception of the incoming call packet by this originally called DTE, or in data transfer phase. To use this facility, the originally called DTE must have subscribed the call transfer subscription facility.

6.29.1 Call Transfer Subscription

Call transfer subscription is an optional user facility, agreed for a period of time. This facility, if subscribed to, enables the DTE to request, by using the call transfer selection facility, that an individual call be transferred to an alternate DTE. The DTE can transfer the call:

- at the time the individual call is presented to it by transmission of an incoming call packet
- at any time in data transfer phase, after the incoming call packet has been accepted by a call accepted packet

6.29.2 Call Transfer Selection

Call transfer 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 transfer subscription. It is encoded as an X.25 facility.

The call transfer selection facility may be used by the called DTE in the clear request packet, in direct response to an incoming call packet, or at any time, by the called DTE, in data transfer phase, to specify the alternate called DTE address to which the call is to be forwarded. If the call transfer 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 alternate called DTE. Up to 16 octets of user data may be included in the clear request packet in this case.

When requested for a given virtual call in response to an incoming call packet, the network transfers the call to the alternate 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 alternate called DTE are those that would have been present in the incoming call packet if the call was a regular call from the calling DTE to the alternate DTE. The call redirection notification facility, with a specific reason, indicated in the call transfer selection reason, is delivered to the alternate DTE if it is subscribed as an X.25 1984 compatible DTE. The called line address modified notification facility, with the same specific reason, is delivered to the calling DTE if it is subscribed as an X.25 1984 compatible DTE.

When requested for a given virtual call in data transfer phase, the network transfers the call to the alternate DTE and notifies the calling DTE as a result of the response of the alternate DTE to the incoming call packet it receives:

- a clear request packet in basic format sent by the alternate DTE will result in a clear indication packet transmitted to the calling DTE, with a called line address modified notification facility included if the calling DTE is an X.25 1984 compatible DTE.
- a call accepted packet sent by the alternate DTE will result in a reset indication packet transmitted to the calling DTE. The cause is the reason of the transfer, the diagnostic is 00.

The X.25 facilities that are present in the incoming call packet transmitted to the alternate called DTE are those that would have been present in the incoming call packet if the call was a regular call from the calling DTE to the alternate DTE.

6.29.3 Call Redirection Notification

The call redirection notification facility is included by the DCE in the incoming call packet to inform the alternate DTE that the call has been transferred, and to indicate the address of the originally called DTE, if the alternate DTE is subscribed as an X.25 1984 compatible DTE. The reason indicated in this case is:

- Call transfer by the originally called DTE

6.29.4 Called Line Address Modified Notification

The called line address modified notification facility is included by the DCE in the call connected or clear indication packet to inform the calling DTE that the call has been forwarded, if the calling DTE is subscribed as an X.25 1984 compatible DTE. The reason indicated in this case is:

- Call transfer by the originally called DTE

6.30 DIRECT CALL

Direct call is an optional user facility, **specific to XI**, defined for further study in Recommendation X.2, agreed for a period of time.

The principle of such a facility consists in assigning to one or more than one logical channel of a DTE/DCE interface a complementary subscription parameter allowing the DCE to initiate a virtual call set-up procedure on selected logical channels with parameters defined at subscription time (mainly the address of the called DTE). virtual call set-up on such a logical channel is performed each time the logical channel is turned to state p1: This means that the virtual call will be set-up after the link level initialization and the restart procedure and each time the virtual call will be cleared either by the called DTE, by the DCE in case of network congestion, or by the DTE itself.

When the virtual call is set-up, i.e. when the called DTE has replied to the incoming call packet by a call accepted packet, the DCE issues to the DTE a reset indication with a cause "remote DTE operational" and a specific XI diagnostic "direct call completed". If the virtual call cannot be set-up, the DCE will issue a reset indication with the cause and the diagnostic of the clear request.

During the time the virtual call set-up is attempted, any data packet sent by the DTE will cause the DCE to reply with a reset indication packet, with the cause and the diagnostic of the most recent clearing procedure. If no clearing procedure has occurred, then the cause is "Network out of order" and the diagnostic "Direct call in progress".

In the case where the virtual call set-up procedure fails, and independently of the cause of the failure (network congestion, called DTE busy or out of order,...), the DCE makes Nx1 attempts with a gap of Tx1 seconds after the last clear. Nx1 and Tx1 are part of direct call parameters, but Tx1 will not be lower than a network parameter Tx1min.

These retries occur only if one of the following conditions is met

- the clearing procedure is initiated by the network
- the clearing procedure is initiated by the called DTE, and the direct call logical channel has been subscribed with the reconnection option

A Direct Call logical channel appears to the DTE as a permanent virtual circuit on the primary end (the one which initializes the virtual call set-up), and as a switched virtual circuit at the other end.

7. FORMATS FOR FACILITY FIELDS AND REGISTRATION FIELDS

7.1 GENERAL

The facility field is present only when a DTE is using an optional user facility requiring some indication in the call request, incoming call, call accepted, call connected, clear request, clear indication, or DCE clear confirmation packet.

| The registration field is not used in the XI environment.

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 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/X.25.

TABLE 26/X.25

General Class Coding for Facility/Registration Code Fields

Bits	8 7 6 5 4 3 2 1	
Class A	0 0 X X X X X X	For single octet parameter field
Class B	0 1 X X X X X X	For double octet parameter field
Class C	1 0 X X X X X X	For triple octet parameter field
Class D	1 1 X X X X X X	For 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 19/X.25.

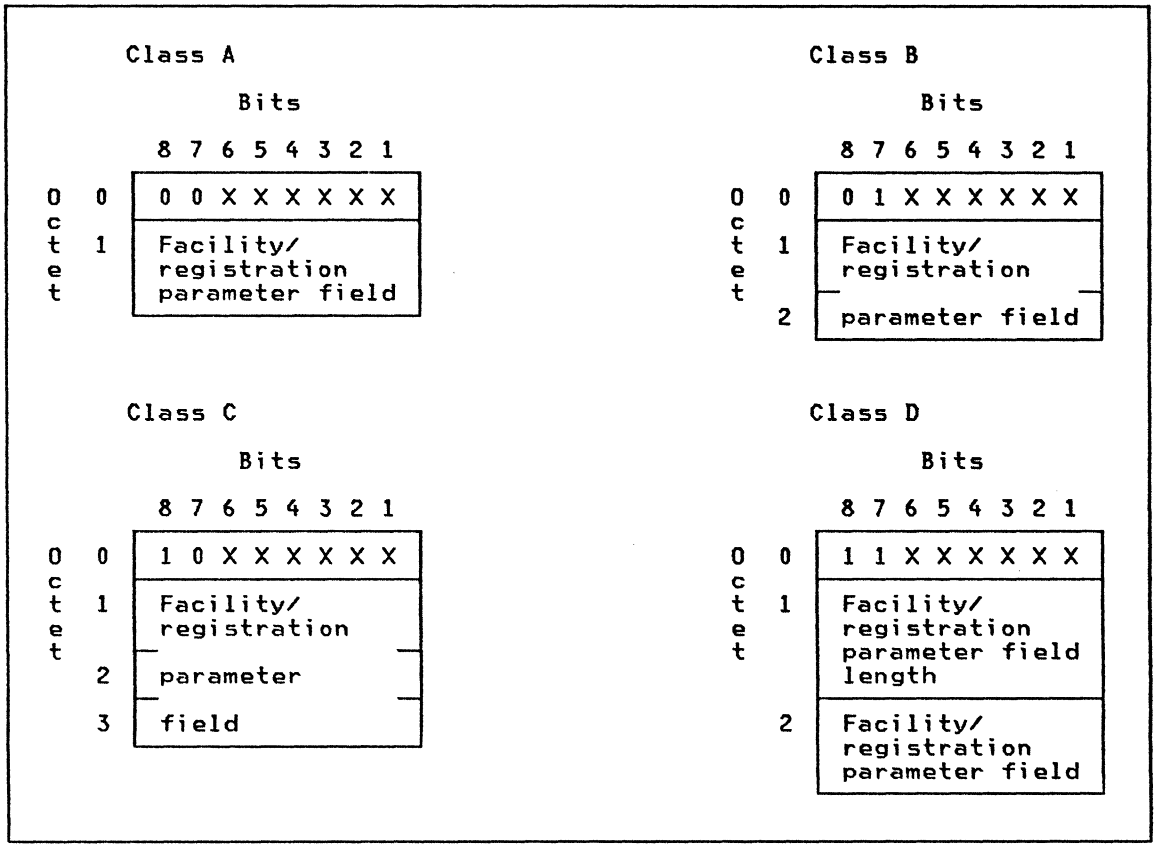


FIGURE 19/X.25

Facility/Registration Element General Format

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 11111111 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, and D as defined above. Repetition of facility/registration code 11111111 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 online 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, other codes may be used for:

- Non X.25 facilities. XI does not offer non-X.25 facilities. The XI-specific call transfer selection facility is encoded as an X.25 facility.

- CCITT-specified DTE facilities as described in Annex G of this Recommendation (call set-up, clear request and clear indication packets).

CCITT specified DTE facilities can be used by DTEs. XI makes use of the extended address facilities for virtual calls established between a DTE attached to an XI network and a DTE attached to a PSDN connected with the XI network.

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)

- Non-X.25 facilities provided by the network to which the calling DTE is connected, in case of internetwork calls (call set-up packets).

If a DTE attached to XI issues a call request with a facility marker parameter set to all zeros, the call is cleared, with cause "invalid facility request" and diagnostic "facility code not allowed".

The facility parameter field of a marker is set to all ones when the marker precedes requests for non-X.25 facilities provided by the network to which the called DTE is connected, in case of intranetwork calls (call set-up packets).

The facility parameter field of a marker is set to 00001111 when the marker precedes requests for CCITT-specified DTE facilities.

All networks will support the facility markers with a facility parameter field set to all ones or to 00001111.

DTEs should not use a facility marker with a facility parameter field set to all ones 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.

In this situation, XI does not clear the call, and the marker with the corresponding facility request is 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.

A call request issued by a DTE attached to an XI node may include a:

- Request for X.25 facilities

- Request for non-X.25 facilities provided by the network to which the called DTE is connected. This may be the case when there is a GW-DTE with a PSDN.

- Request for CCITT-specified DTE facilities.

However, the maximum size of the last two categories of requests (if any), including the separating marker between these two categories (if any), must be lower than or equal to 58 octets.

The coding of CCITT-specified DTE facilities should comply with the description in Annex G. 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.

The only CCITT-defined DTE facilities which are checked by an XI network are the extended address facilities, as described in 5.8.

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/X.25 gives the coding of the facility code fields and the packet types in which they may be present.

The facilities which are supported by XI are:

- flow control parameters negotiation (packet size, window size)
- closed user group selection (basic format)
- closed user group with outgoing access selection (basic format)
- reverse charging
- called line address modified notification
- call redirection notification
- call transfer selection

TABLE 27/X.25 (part 1 of 2)

Coding of the Facility Code Field

Facility	Packet types in which it may be used							Facility code
	Call Req.	Inc. Call	Call Accept.	Call Conn.	Clear Req.	Clear Ind.	DCE Clear Confirm.	Bits 8 7 6 5 4 3 2 1
Flow control parameter negotiation -packet size -window size	X	X	X	X				0 1 0 0 0 0 1 0 0 1 0 0 0 0 1 1
Throughput class negotiation	X	X	X	X				0 0 0 0 0 0 1 0
	not supported by XI							
Closed user group selection -basic format -extended format	X	X						0 0 0 0 0 0 1 1 0 1 0 0 0 1 1 1
Closed user group with outgoing access selection -basic format -extended format	X	X						0 0 0 0 1 0 0 1 0 1 0 0 1 0 0 0
Bilateral closed user group selection	X	X						0 1 0 0 0 0 0 1
	not supported by XI							
Reverse charging	X	X						0 0 0 0 0 0 0 1
Fast select selection	X	X						
	not supported by XI							
Network user identification	X		X					1 1 0 0 0 1 1 0
	not supported by XI							
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
.distance								Further study
.segment count								1 1 0 0 0 0 1 0
.call duration								1 1 0 0 0 0 0 1
	not supported by XI							

TABLE 27/X.25 (part 2 of 2)

Coding of the Facility Code Field

Facility	Packet types in which it may be used							Facility code
	Call Req.	Inc. Call	Call Accept.	Call Conn.	Clear Req.	Clear Ind.	DCE Clear Confirm.	Bits 8 7 6 5 4 3 2 1
RPOA selection -basic format -extended format	X not supported by XI							 0 1 0 0 0 1 0 0 1 1 0 0 0 1 0 0
Called line address modified notification			X (1)	X	X (1)	X		0 0 0 0 1 0 0 0
Call redirection notification		X						1 1 0 0 0 0 1 1
Transit delay selection and indication	X	X		X				0 1 0 0 1 0 0 1
	not supported by XI							
Call transfer selection					X			1 1 0 0 0 0 1 1
	specific to XI							

Note:

1. Not supported by XI for these types of packet

7.2.2 Coding of the Facility Parameter Fields

7.2.2.1 Flow Control Parameter Negotiation Facility

7.2.2.1.1 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.

XI permits packet sizes of between 64 and 1024 octets. The network service provider can define more constraining values.

7.2.2.1.2 Window Size

The window size for the direction of transmission from the called DTE is indicated in bits 7 to 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 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 if extended sequence numbering is used (see 6.2). The ranges of contiguous values allowed by a network for calls with normal numbering and extended numbering are network dependent. All Administrations will provide a window size of 2.

| XI permits window sizes of between 1 and 7 (modulo 8) and between 1 and 15 (modulo 128). The network service provider can define more constraining values.

7.2.2.2 Throughput Class Negotiation Facility

| The Throughput class negotiation facility is not applicable in the XI environment.

7.2.2.3 Closed User Group Selection Facility

7.2.2.3.1 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.

7.2.2.3.2 Extended Format

| The maximum number of closed user groups a DTE can subscribe to with XI is 100, thus the extended format is not permitted.

7.2.2.4 Closed User Group with Outgoing Access Selection Facility

7.2.2.4.1 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.

7.2.2.4.2 Extended Format

| The maximum number of closed user groups a DTE can subscribe to with XI is 100, thus the extended format is not permitted.

7.2.2.5 Bilateral Closed User Group Selection Facility

| The Bilateral closed user group selection facility is not applicable in the XI environment.

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
Bit 1 = 1 for reverse charging requested.

Note - Bits 6, 5, 4, 3, and 2 may be assigned to other facilities in the future; presently, they are set to 0.

| The fast select facility is not applicable in the XI environment.

7.2.2.7 Network User Identification Facility

| The Network user identification facility is not applicable in the XI environment.

7.2.2.8 Charging Information Facility

| The Charging information facility is not applicable in the XI environment.

7.2.2.9 RPOA Selection Facility

| The RPOA selection facility is not applicable in the XI environment.

7.2.2.10 Called Line Address Modified Notification Facility

The coding of the facility parameter field for <u>called line address modified notification</u> is:

Bits: 8 7 6 5 4 3 2 1	
0 0 0 0 0 1 1 1	Call distribution within a Hunt Group (see Note 1)
0 0 0 0 0 0 0 1	Call redirection due to originally called DTE busy
0 0 0 0 1 0 0 1	Call redirection due to originally called DTE out of order
0 0 0 0 1 1 1 1	Call redirection due to prior request from originally called DTE for systematic call redirection
1 0 X X X X X X	DTE originated (see Note 1)
1 1 X X X X X X	Call transfer by the originally called DTE (see Note 2)

Note:

1. Not supported by XI
2. The Xs are those set by the originally called DTE in the <u>call transfer selection</u> facility

7.2.2.11 Call Redirection 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 first octet of the facility parameter field indicates the reason for the call redirection and has one of the following values:

Bits: 8 7 6 5 4 3 2 1	
0 0 0 0 0 0 0 1	Originally called DTE busy
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 X X X X X X	Call transfer by the originally called DTE (see Note 1)

Note:

1. The Xs are those set by the originally called DTE in the <u>call transfer selection</u> facility

The second octet indicates, in bits 4, 3, 2 and 1, 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. Bits 8, 7, 6 and 5 of this octet are set to zero.

The following octets (up to 8) contain the originally called DTE address, coded identically to the called DTE address field in the call request packet (see 5.2.1.3).

7.2.2.12 Transit Delay Selection and Indication Facility

The Transit delay selection and indication facility is not applicable in the XI environment.

7.2.2.13 Call Transfer 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 transferred.

The first octet of the facility parameter field indicates the reason for the DTE transferring the call. The coding of this octet is:

Bits: 8 7 6 5 4 3 2 1

1 1 X X X X X X

Note: Each X may be independently set to 0 or 1 by the called DTE and is passed transparently to the DTE to which the call is transferred. If bits 8 and 7 are not set to 1 by the called DTE, they are forced to this value by the DCE

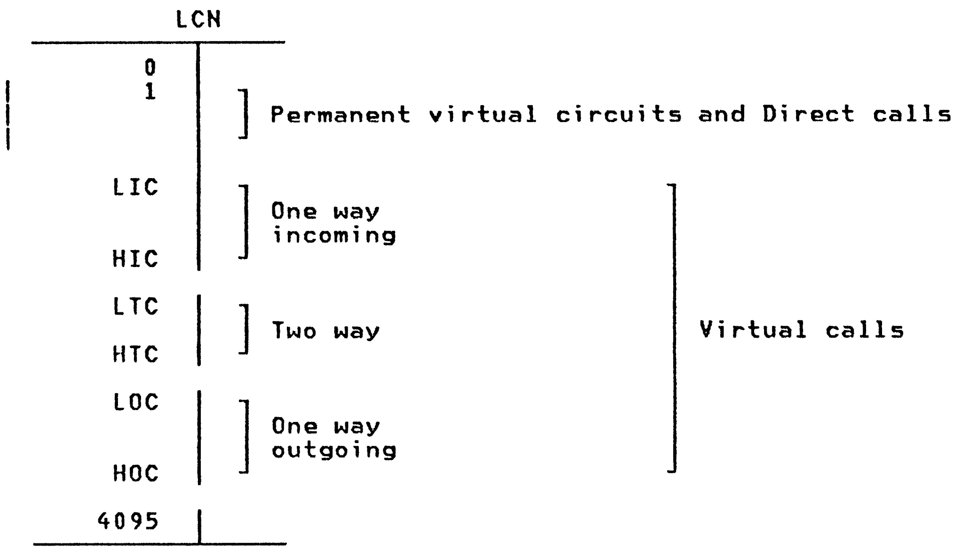
7.3 CODING OF THE REGISTRATION CODE FIELD OF REGISTRATION PACKETS

The coding of the registration code field of registration packets is not applicable in the XI environment.

ANNEX A. RANGE OF LOGICAL CHANNELS USED FOR VIRTUAL CALLS AND PERMANENT VIRTUAL CIRCUITS

In the case of a single logical channel DTE, logical channel 1 will be used.

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/X.25.



LCN Logical channel number
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

Logical channels 1 to LIC-1: range of logical channels which may be assigned to permanent virtual circuits.
Logical channels LIC to HIC: range of logical channels which are assigned to one-way incoming logical channels for virtual calls (see 6.8).
Logical channels LTC to HTC: range of logical channels which are assigned to two-way logical channels for virtual calls.
Logical channels LOC to HOC: range of logical channels which are assigned to one-way outgoing logical channels for virtual calls (see 6.7).
Logical channels HIC#1 to LTC-1, HTC#1 to LOC-1, and HOC#1 to 4095 are non-assigned logical channels.

FIGURE A-1/X.25

Note 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 1 followed by bit positions 8 through 1 of octet 2 with bit 1 of octet 2 as the low order bit.

Note 2 - All logical channel boundaries are agreed with the Administration for a period of time.

For XI, the assigned logical channels within a logical channel group must be consecutive (no gaps) and must start from the first value in this group, i.e., from 1 in group 0 and 256xN in group N (where N < 16). A particular range of logical channels can extend over more than one logical channel group.

Note 3 - In order to avoid frequent rearrangement of logical channels, not all logical channels within the range for permanent virtual circuits are necessarily assigned.

With XI, not all logical channels within the range for permanent virtual circuits are necessarily assigned at subscription time. Moreover, a logical channel assigned to a permanent virtual circuit can be active or not depending on whether the permanent virtual circuit has been activated or not by an appropriate operator command.

A logical channel which is assigned to a permanent virtual circuit is to be assigned with a complementary status (specific to XI) indicating whether the logical channel is primary or secondary. This status does not modify the procedure nor the state diagrams at the DTE/DCE interface, but is used by the XI node to activate or re-activate the permanent virtual circuit after a network failure.

Direct Call logical channels are assigned within the range of PVCs.

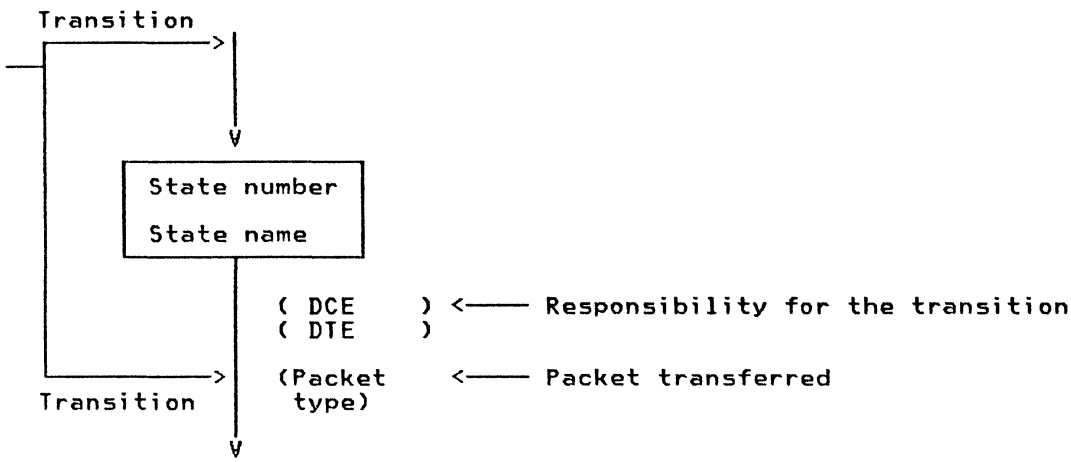
The maximum number of logical channels and their ranges are necessarily part of the configuration of the XI node. However, the assignment of logical channels can be modified through appropriate operator commands that enable or disable logical channels.

Note 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.

Note 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 of LIC to HIC and LTC to HTC.

Note 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.

B.1 SYMBOL DEFINITION OF THE STATE DIAGRAMS



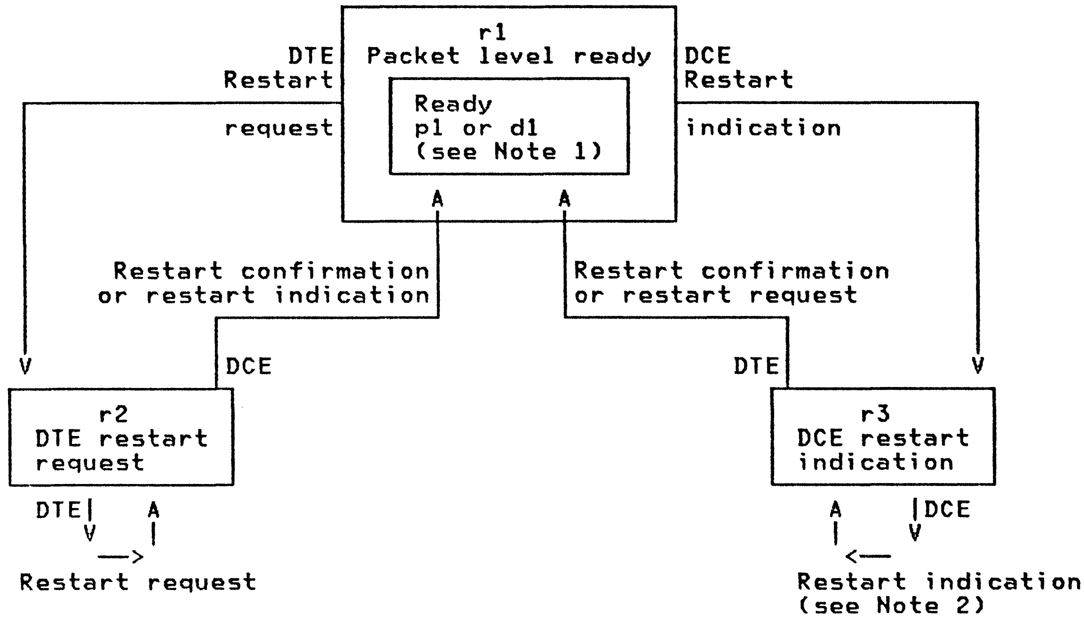
Note 1 - Each state is represented by a box wherein the state name and number are indicated.

Note 2 - Each state transition is represented by an arrow. The responsibility for the transition (DTE or DCE) and the packet that has been transferred is indicated beside that arrow.

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 has been done by the following means:

- The figures are arranged in order of priority with Figure B-1/X.25 (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 an ellipse in the higher order diagram.



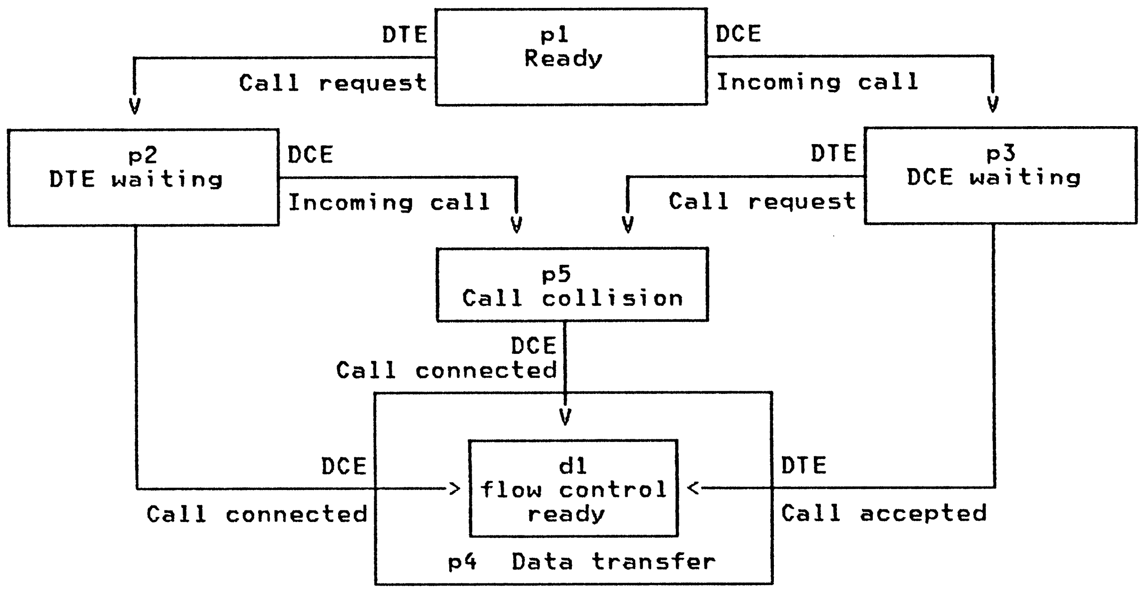
<u>Note 1</u> – State p1 for virtual calls or state d1 for permanent virtual circuits.

<u>Note 2</u> – This transition may take place after time-out T10.

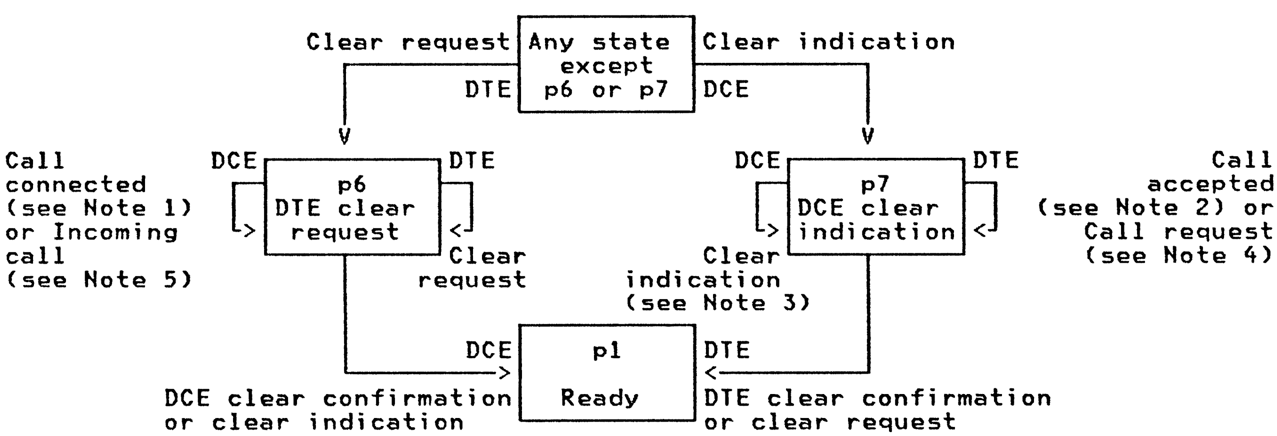
FIGURE B-1/X.25

<u>Diagram of States for the Transfer of Restart Packets</u>

For XI, the DCE state r2 is transient, as the DCE will immediately send a restart confirmation just after a restart request has been received. Moreover, the DCE will send a restart indication each time the link level is set up or reset.



a) Call set-up phase



b) Call clearing phase

Note 1 — This transition is possible only if the previous state was DTE Waiting (p2).

Note 2 — This transition is possible only if the previous state was DCE Waiting (p3).

Note 3 — This transition may take place after time-out T13.

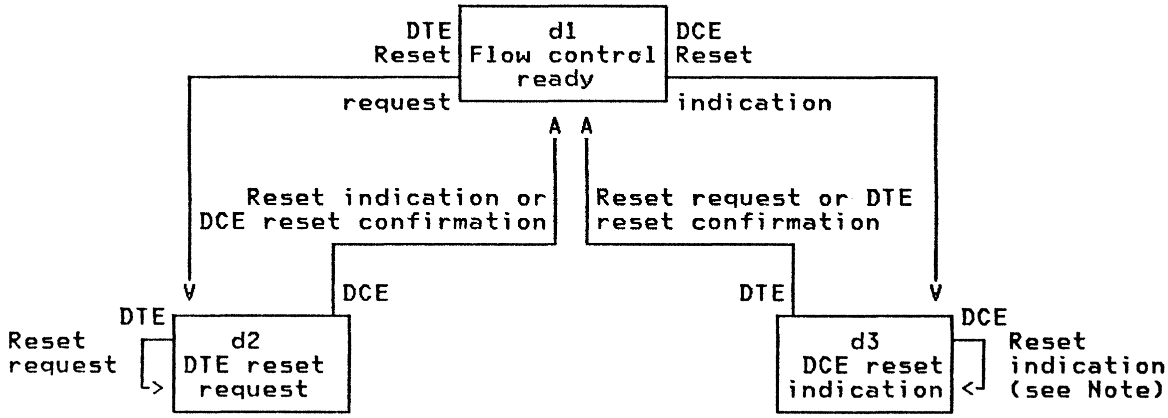
Note 4 — This transition is possible only if the previous state was Ready (p1) or DCE Waiting (p3).

Note 5 — This transition is possible only if the previous state was ready (p1) or DTE Waiting (p2).

FIGURE B-2/X.25

Diagram of States for the Transfer of Call Set-up and Call Clearing Packets within the Packet Level Ready (r1) State

For XI, the DCE state p6 is transient, as the DCE will immediately send a clear confirmation just after the reception of a clear request from the DTE (the clear confirmation has local significance).



Note – This transition may take place after time-out T12.

FIGURE B-3/X.25

Diagram of States for the Transfer of Reset Packets within the Data Transfer (p4) State

For XI, the DCE state d2 is transient, as the DCE will immediately send a reset confirmation just after the reception of a reset request from the DTE (the reset confirmation has local significance).

IN A GIVEN STATE OF THE PACKET LEVEL DTE/DCE INTERFACE AS PERCEIVED BY THE DCE

C.1 INTRODUCTION

This annex specifies the actions taken by the DCE on receipt of packets in a given state of the packet level 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:

1. 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 .

2. For those networks which are octet aligned, the detection of a non-integral number of octets may be made at the frame or packet level. In this annex, only those networks which are octet aligned and detect the non-integral number of octets at the packet level are concerned with the considerations about octet alignment.

   XI networks are octet aligned and the detection of packets not including an integral number of octets is performed at link level.

3. 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 which implement the diagnostic packet, transmits to the DTE a diagnostic packet containing the diagnostic # x. The state of the interface is not changed.

     XI networks make use of the diagnostic packet.

   - NORMAL or ERROR: the corresponding action is specified after each table.

4. Annex E gives a list of the diagnostic codes which may be used.

TABLE C1/X.25

Special Cases

Packet from the DTE	Any state
Any packet with packet length shorter than 2 octets, including link level 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 bits 1 to 4 of octet 1 and bits 1 to 8 of octet 2 equal to 0	(see Table C-2/X.25)

TABLE C2/X.25

Action Taken by the DCE on Receipt of Packets in a Given State of the Packet Level DTE/DCE Interface as Perceived by the DCE: Restart and Registration Procedure

State of the interface as perceived by the DCE —> / Packet from the DTE ↓	Packet level ready r1	DTE restart request r2	DCE restart indication r3
Restart request	NORMAL (r2)	DISCARD	NORMAL (r1)
DTE restart confirmation	ERROR (r3) # 17	ERROR (r3) # 18	NORMAL (r1)
Data, interrupt, call set-up and clearing, flow control or reset	See Table C-3/X.25 or C-4/X.25 (see Note)	ERROR (r3) # 18	DISCARD
Restart request, DTE restart confirmation or registration request with bits 1 to 4 of octet 1 or bits 1 to 8 of octet 2 unequal to zero	See Table C-3/X.25 or C-4/X.25 (see Note)	ERROR (r3) # 41	DISCARD
Packet having a packet type identifier which is shorter than 1 octet	See Table C-3/X.25 or C-4/X.25 (see Note)	ERROR (r3) # 38	DISCARD
Packet having a packet type identifier which is undefined or not supported by the DCE (that is, reject or registration packet)	See Table C-3/X.25 or C-4/X.25 (see Note)	ERROR (r3) # 33	DISCARD
Packet other than restart request, DTE restart confirmation and registration request with bits 1 to 4 of octet 1 and bits 1 to 8 of octet 2 equal to zero	DIAG # 36	DIAG # 36	DIAG # 36
Registration request	NORMAL (r1)	NORMAL (r2)	NORMAL (r3)

Note – Table C-3/X.25 for logical channels assigned to virtual calls, Table C-4/X.25 for logical channels assigned to permanent virtual circuits.

| If XI receives a registration packet in state r1, it handles it as an ERROR (r3) # 33, i.e., issues a restart indication, cause "local procedure error" and diagnostic "unidentifiable packet".

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, the distant DTE is 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, the distant DTE will be informed by a reset indication packet, with the cause "Remote procedure error" (same diagnostic).

NORMAL (r1):

Provided none of the following error conditions has occurred, the action taken by the DCE follows the procedure as defined in 3 and 6.1, and the DTE/DCE interface enters state r1:

a. 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 annex), the DCE will invoke the ERROR # 39, # 38 or # 82 procedure, respectively.

   Registration request packets are not applicable in the XI environment.

   XI networks invoke the ERROR # 81 procedure, if the restarting cause field is not "DTE originated" in the restart request packet received in state r3.

b. 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 of this annex), the DCE shall invoke the DIAG # 39, # 38, or # 82 procedure, respectively.

   XI networks invoke the DIAG # 81 procedure, if the restarting cause field is not "DTE originated" in the restart request packet received in state r1.

c. 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 (see Annex F) is received when it is possible to make the 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 channels assigned to permanent virtual circuits. This action ensures that the permanent virtual circuits are reset so that all of the negotiated facilities can take effect properly.

TABLE C3/X.25

Action Taken by the DCE on Receipt of Packets in a Given State of the Packet Level DTE/DCE Interface as Perceived by the DCE: Call Set-up and Clearing on Logical Channel Assigned to Virtual Call (See Note 1)

State of the interface as perceived by the DCE ———>	Packet level ready r1						
Packet from the DTE with logical channel assigned to virtual call V	Ready p1	DTE waiting p2 (see Note 3)	DCE waiting p3 (see Note 2)	Data transfer p4	Call collision p5 (see Notes 2 and 3)	DTE clear request p6	DCE clear indication p7
Call request	NORMAL (p2)	ERROR (p7) # 21	NORMAL (p5)	ERROR (p7) # 23	ERROR (p7) # 24	ERROR (p7) # 25	DISCARD
Call accepted	ERROR (p7) # 20	ERROR (p7) # 21	NORMAL (p4)	ERROR (p7) # 23	ERROR (p7) # 24	ERROR (p7) # 25	DISCARD
Clear request	NORMAL (p6)	NORMAL (p6)	NORMAL (p6)	NORMAL (p6)	NORMAL (p6)	DISCARD	NORMAL (p1)
DTE clear confirmation	ERROR (p7) # 20	ERROR (p7) # 21	ERROR (p7) # 22	ERROR (p7) # 23	ERROR (p7) # 24	ERROR (p7) # 25	NORMAL (p1)
Data, interrupt, reset, or flow control	ERROR (p7) # 20	ERROR (p7) # 21	ERROR (p7) # 22	See Table C-4/X.25	ERROR (p7) # 24	ERROR (p7) # 25	DISCARD
Restart request, DTE restart confirmation, or registration request with bits 1 to 4 of octet 1 or bits 1 to 8 of octet 2 unequal to zero	ERROR (p7) # 41	ERROR (p7) # 41	ERROR (p7) # 41	See Table C-4/X.25	ERROR (p7) # 41	ERROR (p7) # 41	DISCARD
Packets having a packet type identifier which is shorter than one octet	ERROR (p7) # 38	ERROR (p7) # 38	ERROR (p7) # 38	See Table C-4/X.25	ERROR (p7) # 38	ERROR (p7) # 38	DISCARD
Packets having a packet type identifier which is undefined or not supported by the DCE (i.e., reject or registration packet)	ERROR (p7) # 33	ERROR (p7) # 33	ERROR (p7) # 33	See Table C-4/X.25	ERROR (p7) # 33	ERROR (p7) # 33	DISCARD

Note 1 - On permanent virtual circuit, only state P4 exists and the DCE takes no action except those specified in Table C-4/X.25.

Note 2 - This state does not exist in the case of an outgoing one-way logical channel (as perceived by the DTE).

Note 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 distant DTE is also informed of the clearing by a clear indication packet, with the cause "Remote procedure error" (same diagnostic).

NORMAL (p1):

Provided none of the following error conditions has occurred, the action taken by the DCE follows the procedures as defined in 4 and the DTE/DCE interface enters state p1. In all the cases specified hereunder, 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

Error condition	Cause	Specific diagnostics (see Note 3 of Annex E)
1 Packet not octet aligned (see rule 2 in the introduction of this annex)	Local procedure error	# 82
2 Incoming one-way logical channel (as perceived by the DTE)	Local procedure error	# 34
3 Address contains a non-BCD digit	Local procedure error	# 67, 68
4 Invalid calling DTE address (see Note)	Local procedure error	# 68
5 Invalid called DTE address (see Note)	Local procedure error or Not obtainable	# 67 # 67

Note - Possible reasons for invalid address include:

- Prefix digit no supported
- National address smaller than national address format permits
- National address larger than national address format permits
- DNIC less than four digits, etc.

In the case of XI, invalid addresses are addresses which do not comply with the rules given in 5.8 or which do not comply with the addressing scheme established by the network service provider.

Error condition	Cause	Specific diagnostics (see Note 3 of Annex E)
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 request	# 65
10 Facility value not allowed or invalid	Invalid facility request	# 66
11 Invalid network user identification	Invalid facility request	# 66
12 Network user identification facility expected by the DCE and not provided by the DTE	Local procedure error	# 76
13 Facility values conflicts (for example, a particular combination not supported)	Invalid facility request	# 66
14 CCITT specified DTE facility code or parameter not allowed or invalid	Invalid facility request	# 77
15 Packet too short	Local procedure error	# 38
16 Address length larger than remainder of packet	Local procedure error	# 38
17 Call user data larger than 16 or 128 in case of fast select facility	Local procedure error	# 39
18 Class coding of the facility corresponding to a length of parameter larger than remainder of packet	Local procedure error	# 69
19 Facility code repeated	Local procedure error	# 73

If the virtual call cannot be established by the network, the DCE should use a call progress signal and diagnostic code among the following:

Error condition	Cause	Specific diagnostics (see Note 3 of Annex E)
20 Unknown number	Not obtainable	# 67
21 Incoming call barred	Access barred	# 70
22 Closed user group protection	Access barred	# 65
23 Ship absent	Ship absent	# 0
24 Reverse charging rejected	Reverse charging acceptance not subscribed	# 0
25 Fast select rejected	Fast select acceptance not subscribed	# 0
26 Called DTE out of order	Out of order	# 0 # greater than 127
27 No logical channel available	Number busy	# 71
28 Call collision	Number busy	# 71, 72
29 RPOA out of order	RPOA out of order	# 0
30 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.		
31 Procedure error at the remote DTE/DCE interface	Remote procedure error	(see 2. and 3. below and Annex D)
32 Temporary network congestion or fault condition within the network	Network congestion	# 0, # 122 # greater than 127

b) Call accepted packet

Error condition	Cause	Specific diagnostics (see Note 3 of Annex E)
1 Packet not octet aligned (see rule 2 in the introduction of this annex)	Local procedure error	# 82
2 Address contains a non-BCD digit	Local procedure error	# 67, 68
3 Invalid calling DTE address (see Note under 1.)	Local procedure error	# 68
4 Invalid called DTE address (see Note under 1.)	Local procedure error	# 67
5 Value of the facility length field greater than 109	Local procedure error	# 69
6 No combination of facilities could equal facility length	Local procedure error	# 69
7 Facility length larger than remainder of packet	Local procedure error	# 38
8 Facility code not allowed	Invalid facility request	# 65
9 Facility value not allowed or invalid	Invalid facility request	# 66
10 Invalid network user identification	Invalid facility request	# 66
11 Network user identification facility expected by the DCE and not provided by the DTE	Local procedure error	# 76
12 Facility values conflicts (for example, a particular combination not supported)	Invalid facility request	# 66
13 Address length larger than remainder of packet	Local procedure error	# 38
14 Called user data larger than 128 (if fast select facility requested)	Local procedure error	# 39
15 Called user data present (if fast select facility not requested)	Local procedure error	# 39
16 Class coding of the facility corresponding to a length of parameter field larger than remainder of packet	Local procedure error	# 69
17 Facility code repeated	Local procedure error	# 73
18 The incoming call packet indicated fast select with restriction on response	Local procedure error	# 42
19 DTE facility code or parameter not allowed or invalid	Invalid facility request	# 77

Some networks may 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 address modified notification facility is present in the facility field.

| The behaviour of an XI network regarding addresses is given in 5.8.

c) Clear request packet

Error condition	Cause	Specific diagnostics (see Note 3 of Annex E)
1 Packet not octet aligned (see rule 2 in the introduction of this annex)	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 field not set to zero (at any time); called DTE address length field not set to zero except when the called line address modified notification facility is present in clearing a call in state 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 under 1.)	Local procedure error	# 67
6 Value of the facility length field greater than 109	Local procedure error	# 69
7 Clear user data larger than 128 (if fast select facility requested)	Local procedure error	# 39
8 Clear user data present (if fast select facility not requested)	Local procedure error	# 39
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 request	# 65
12 Facility value not allowed or invalid	Invalid facility request	# 66
13 Class coding of the facility corresponding to a parameter field length larger than remainder of packet	Local procedure error	# 69
14 Facility code repeated	Local procedure error	# 73

| XI 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

Error condition	Cause	Specific diagnostics (see Note 3 of Annex E)
1 Packet not octet aligned (see rule 2 in the introduction of this annex)	Local procedure error	# 82
2 Packet length greater than 3 octets	Local procedure error	# 39

TABLE C-4/X.25

Action Taken by the DCE on Receipt of Packets in a Given State of the Packet Level DTE/DCE Interface as Perceived by the DCE: Transfer (Flow Control and Reset) on Assigned Logical Channels

State of the interface as perceived by the DCE —>	Data transfer p4		
Packet from the DTE with assigned logical channel | V	Flow control ready d1	DTE reset request d2	DCE reset indication d3
Restart 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 registration request with bits 1 to 4 of octet 1 or bits 1 to 8 of octet 2 unequal to zero	ERROR (d3) # 41	ERROR (d3) # 41	DISCARD
Packet having a packet type identifier which is shorter than 1 octet	ERROR (d3) # 38	ERROR (d3) # 38	DISCARD
Packet having a packet type identifier which is undefined or not supported by the DCE (that is, reject or registration packet)	ERROR (d3) # 33	ERROR (d3) # 33	DISCARD
Invalid packet type on a permanent virtual circuit	ERROR (d3) # 35	ERROR (d3) # 35	DISCARD
Reject packet not subscribed	ERROR (d3)) # 37	ERROR (d3) # 37	DISCARD

ERROR (d3) # 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 by a reset indication packet, with the cause "Remote procedure error" (same diagnostic).

NORMAL (d1):

Provided none of the following error conditions or special situations has occurred, the actions taken by the DCE follow the procedure as defined in 4:

a) If the packet exceeds the maximum permitted length, is too short, is not octet aligned (see rule 2 in the introduction of this annex), the DCE will invoke the ERROR # 39, # 38, # 82 procedure, respectively.

b) XI networks invoke the ERROR # 81 procedure if the resetting cause field in a reset request packet does not have the value "DTE originated".

c) XI networks invoke the ERROR # 83 procedure, if the Q bit is not set to the same value within a complete packet sequence.

d) If the P(S) or P(R) received is not valid, the DCE will invoke the ERROR # 1 or # 2 procedure respectively.

e) 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.

f) 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).

ANNEX D. PACKET LEVEL DCE TIME-OUTS AND DTE TIME-LIMITS

D.1 DCE TIME-OUTS

Under certain circumstances this Recommendation requires the DTE to respond to a packet issued from the DCE within a stated maximum time.

Table D-1/X.25 covers these circumstances and the actions that the DCE will initiate upon the expiration of that time.

The time-out values used by the DCE will never be less than those indicated in Table D-1/X.25.

XI makes use of the time-out values indicated in Table D-1/X.25. These values are defined by the network service provider

In table D-1/X.25, it is indicated that under certain cases of non-response from the DTE (case of permanent virtual circuit), the DCE may issue remote procedure error condition at the remote DTE/DCE interface; that is not the case for XI. However, if the remote DTE tries to send data, interrupt, or flow control packets while a retransmission procedure is performed at the local DTE/DCE interface, then the remote DCE will issue a remote procedure error condition at each attempt from the remote DTE.

D.2 DTE TIME-LIMITS

Under certain circumstances, this Recommendation requires the DCE to respond to a packet from the DTE within a stated maximum time. Table D-2/X.25 gives these maximum times. 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, the DTE may incorporate timers. The time-limits given in Table D-2/X.25 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/X.25.

Note - A DTE may use a time shorter than the value given for T21 in Table D-2/X.25. 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.

Note - XI makes use of the diagnostic packet each time this possibility is quoted in Table D-1/X.25.

TABLE D-1/X.25 (Part 1 of 2)

DCE Time-outs (First Time)

Time-out number	Time-out value	Started when	State of the logical channel	Normally terminated when	Actions to be taken the first time the time-out expires	
					Local side	Remote side
T10	60 s	DCE issues a restart indication	r3	DCE leaves the r3 state (that is, the restart confirmation or restart request is received)	DCE remains in r3, signals a restart indication (local procedure error # 52) again, and restarts time-out T10	For permanent virtual circuits, DCE may enter the d3 state signaling a reset indication (remote procedure error # 52)
T11	180 s	DCE issues an incoming call	p3	DCE leaves the p3 state (that is, the call accepted, clear request, or call request is received)	DCE enters the p7 state signaling a clear indication (local procedure error # 49)	DCE enters the p7 state signaling a clear indication (remote procedure error # 49)
T12	60 s	DCE issues a reset indication	d3	DCE leaves the d3 state (that is, the reset confirmation or reset request is received)	DCE remains in d3, signals a reset indication (local procedure error # 51) again, and restarts time-out T12	DCE may enter the d3 state signaling a reset indication (remote procedure error # 51)
T13	60 s	DCE issues a clear indication	p7	DCE leaves the p7 state (that is, the clear confirmation or clear request is received)	DCE remains in p7, signals a clear indication (local procedure error # 50) again, and restarts time-out T13	
Tx1 (XI)	20 s	a DC-type virtual call is cleared by the network	XI specific	timer expires	DCE on primary side sends a call request packet on the DC-type logical channel	

TABLE D-1/X.25 (Part 2 of 2)

DCE Time-outs (Second Time)

Time-out number	Time-out value	Started when	State of the logical channel	Normally terminated when	Actions to be taken the second time the time-out expires	
					Local side	Remote side
T10	60 s	DCE issues a restart indication	r3	DCE leaves the r3 state (that is, the restart confirmation or restart request is received)	DCE enters the r1 state and may issue a diagnostic packet (# 52)	For permanent virtual circuits, DCE may enter the d3 state signaling a reset indication (remote procedure error # 52)
T11	180 s	DCE issues an incoming call	p3	DCE leaves the p3 state (that is, the call accepted, clear request, or call request is received)		
T12	60 s	DCE issues a reset indication	d3	DCE leaves the d3 state (that is, the reset confirmation or reset request is received)	For virtual calls, DCE enters the p7 state signaling a clear indication (local procedure error # 51). For permanent virtual circuits DCE enters the d1 state and may issue a diagnostic packet (# 51)	For virtual calls, DCE enters the p7 state signaling a clear indication (remote procedure error # 51). For permanent virtual circuits, DCE may enter the d3 state signaling a reset indication (remote procedure error # 51)
T13	60 s	DCE issues a clear indication	p7	DCE leaves the p7 state (that is, the clear confirmation or clear request is received)	DCE enters the p1 state and may issue a diagnostic packet (# 50)	
Tx1 (XI)	20 s	a DC-type virtual call is cleared by the network	XI specific	timer expires	DCE on primary side sends a call request packet on the DC-type logical channel	

TABLE D-2/X.25

DTE Time-limits

Time-out number	Time-limit value	Started when	State of the logical channel	Normally terminated when	Preferred action to be taken when time-limit expires
T20	180 s	DTE issues a restart request	r2	DTE leaves the r2 state (that is, the restart confirmation or restart indication is received)	To retransmit the restart request (see Note 1)
T21	200 s	DTE issues a call request	p2	DTE leaves the p2 state (that is, the call connected, clear indication or incoming call is received)	To transmit a clear request
T22	180 s	DTE issues a reset request	d2	DTE leaves the d2 state (that is, the reset confirmation or reset indication is received)	For virtual calls, to retransmit the reset request or to transmit a clear request. For permanent virtual call circuits, to retransmit the reset request (see Note 2)
T23	180 s	DTE issues a clear request	p6	DTE leaves the p6 state (that is, the clear confirmation or clear indication is received)	To transmit the clear request (see Note 2)
T28 (see Note 3)	300 s	DTE issues a registration request	Any	DTE receives the registration confirmation or a diagnostic packet	May retransmit the registration request, but should at some point recognize that the on-line facility registration facility is not offered

Note 1 - After unsuccessful retries, recovery decisions should be taken at higher levels.

Note 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.

Note 3 - The DTE timers T24 through T27 have been assigned by ISO in the specification of the packet level for X.25 DTEs. To avoid ambiguity and confusion, the time-out number has therefore been assigned T28.

IN CLEAR, RESET AND RESTART INDICATION, REGISTRATION CONFIRMATION AND DIAGNOSTIC PACKETS

Some of the diagnostics described here are not generated by an XI network. Some of them can be received by DTEs attached to an XI node only when the XI network is connected to a PSDN through the GW-DTE function.

In principle, when there is no ambiguity about the cause of the clear, reset, or restart, XI avoids using generic codes.

Some XI specific diagnostics are added to the CCITT list when no relevant code is available. These codes are chosen from the value 128, upwards, as required by the Recommendation.

TABLE E-1/X.25 (part 1 of 3)

(See Notes 1, 2, and 3)

Diagnostics	Bits 8 7 6 5 4 3 2 1	Hexa decimal	Decimal
No additional information	0 0 0 0 0 0 0 0	00	0
Invalid P(S)	0 0 0 0 0 0 0 1	01	1
Invalid P(R)	0 0 0 0 0 0 1 0	02	2
	0 0 0 0 1 1 1 1	0F	15
Packet type invalid	0 0 0 1 0 0 0 0	10	16
For state r1	0 0 0 1 0 0 0 1	11	17
For state r2	0 0 0 1 0 0 1 0	12	18
For state r3	0 0 0 1 0 0 1 1	13	19
For state p1	0 0 0 1 0 1 0 0	14	20
For state p2	0 0 0 1 0 1 0 1	15	21
For state p3	0 0 0 1 0 1 1 0	16	22
For state p4	0 0 0 1 0 1 1 1	17	23
For state p5	0 0 0 1 1 0 0 0	18	24
For state p6	0 0 0 1 1 0 0 1	19	25
For state p7	0 0 0 1 1 0 1 0	1A	26
For state d1	0 0 0 1 1 0 1 1	1B	27
For state d2	0 0 0 1 1 1 0 0	1C	28
For state d3	0 0 0 1 1 1 0 1	1D	29
	0 0 0 1 1 1 1 1	1F	31
Packet not allowed	0 0 1 0 0 0 0 0	20	32
Unidentifiable packet	0 0 1 0 0 0 0 1	21	33
Call on one-way logical channel	0 0 1 0 0 0 1 0	22	34
Invalid packet type on a permanent virtual circuit	0 0 1 0 0 0 1 1	23	35
Packet on unassigned logical channel	0 0 1 0 0 1 0 0	24	36
Reject not subscribed to	0 0 1 0 0 1 0 1	25	37
Packet too short	0 0 1 0 0 1 1 0	26	38
Packet too long	0 0 1 0 0 1 1 1	27	39
Invalid general format identifier	0 0 1 0 1 0 0 0	28	40
Restart or registration packet with non-zero in bits 1 to 4 of octet 1, or bits 1 to 8 of octet 2	0 0 1 0 1 0 0 1	29	41
Packet type not compatible with facility	0 0 1 0 1 0 1 0	2A	42
Unauthorized interrupt confirmation	0 0 1 0 1 0 1 1	2B	43
Unauthorized interrupt	0 0 1 0 1 1 0 0	2C	44
Unauthorized reject	0 0 1 0 1 1 0 1	2D	45
	0 0 1 0 1 1 1 1	2F	47
Time expired	0 0 1 1 0 0 0 0	30	48
For incoming call	0 0 1 1 0 0 0 1	31	49
For clear indication	0 0 1 1 0 0 1 0	32	50
For reset indication	0 0 1 1 0 0 1 1	33	51
For restart indication	0 0 1 1 0 1 0 0	34	52
	0 0 1 1 1 1 1 1	3F	63

TABLE E-1/X.25 (part 2 of 3)

(See Notes 1, 2, and 3)

Diagnostics	Bits	Hexa decimal	Decimal
	8 7 6 5 4 3 2 1		
Call set-up, call clearing or registration problem	0 1 0 0 0 0 0 0	40	64
Facility/registration code not allowed	0 1 0 0 0 0 0 1	41	65
Facility parameter not allowed	0 1 0 0 0 0 1 0	42	66
Invalid called address	0 1 0 0 0 0 1 1	43	67
Invalid calling address	0 1 0 0 0 1 0 0	44	68
Invalid facility/registration length	0 1 0 0 0 1 0 1	45	69
Incoming call barred	0 1 0 0 0 1 1 0	46	70
No logical channel available	0 1 0 0 0 1 1 1	47	71
Call collision	0 1 0 0 1 0 0 0	48	72
Duplicate facility requested	0 1 0 0 1 0 0 1	49	73
Non zero address length	0 1 0 0 1 0 1 0	4A	74
Non zero facility length	0 1 0 0 1 0 1 1	4B	75
Facility not provided when expected	0 1 0 0 1 1 0 0	4C	76
Invalid CCITT-specified DTE facility	0 1 0 0 1 1 0 1	4D	77
	0 1 0 0 1 1 1 1	4F	79
Miscellaneous	0 1 0 1 0 0 0 0	50	80
Improper cause code from DTE	0 1 0 1 0 0 0 1	51	81
Not aligned octet	0 1 0 1 0 0 1 0	52	82
Inconsistent Q bit setting	0 1 0 1 0 0 1 1	53	83
	0 1 0 1 1 1 1 1	5F	95
Not assigned	0 1 1 0 0 0 0 0	60	96
	0 1 1 0 1 1 1 1	6F	111
International problem	0 1 1 1 0 0 0 0	70	112
Remote network problem	0 1 1 1 0 0 0 1	71	113
International protocol problem	0 1 1 1 0 0 1 0	72	114
International link out of order	0 1 1 1 0 0 1 1	73	115
International link busy	0 1 1 1 0 1 0 0	74	116
Transit network facility problem	0 1 1 1 0 1 0 1	75	117
Remote network facility problem	0 1 1 1 0 1 1 0	76	118
International routing problem	0 1 1 1 0 1 1 1	77	119
Temporary routing problem	0 1 1 1 1 0 0 0	78	120
Unknown called DNIC	0 1 1 1 1 0 0 1	79	121
Maintenance action (see Note 4)	0 1 1 1 1 0 1 0	7A	122
	0 1 1 1 1 1 1 1	7F	127

TABLE E-1/X.25 (part 3 of 3)

(See Notes 1, 2, and 3)

Diagnostics	Bits 8 7 6 5 4 3 2 1	Hexa decimal	Decimal
Reserved for network specific diagnostic information	1 0 0 0 0 0 0 0	80	128
subscription error	1 0 0 0 0 0 0 1	81	129
permanent virtual circuit not activated	1 0 0 0 0 0 1 0	82	130
remote access link event/status:			
-link level not initiated or restart indication pending	1 0 0 0 0 0 1 1	83	131
-line or modems failure	1 0 0 0 0 1 0 0	84	132
-DISC from the DTE	1 0 0 0 0 1 0 1	85	133
-disconnected by operator	1 0 0 0 0 1 1 0	86	134
-SABM/UA exchange completed	1 0 0 0 0 1 1 1	87	135
-DM sent by the DCE	1 0 0 0 1 0 0 0	88	136
previous reset not confirmed	1 0 0 0 1 0 0 1	89	137
call transfer in progress	1 0 0 0 1 0 1 0	8A	138
direct call in progress	1 0 0 0 1 0 1 1	8B	139
direct call set-up completed	1 0 0 0 1 1 0 0	8C	140
invalid called address extension	1 0 0 0 1 1 0 1	8D	141
user facilities length larger than 58	1 0 0 0 1 1 1 0	8E	142
invalid call transfer address	1 0 0 0 1 1 1 1	8F	143
call transfer not supported on calling side	1 0 0 1 0 0 0 0	90	144
	1 1 1 1 1 1 1 1	FF	255

Note 1 - Not all diagnostic codes need apply to a specific network, but those used are as coded in the table.

Note 2 - A given diagnostic need not apply to all packet types (i.e., reset indication, clear indication, restart indication, registration confirmation, and diagnostic packets).

Note 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.

Note 4 - This diagnostic may also apply to a maintenance action within a national network.

Note 5 - XI specific diagnostic codes between 131 and 136 are issued associated with the cause "out of order", to give more information to the remote DTE.

ANNEX F. APPLICABILITY OF THE ONLINE FACILITY REGISTRATION FACILITY TO OTHER FACILITIES

The applicability of the online facility registration facility to other facilities is not applicable in the XI environment.

ANNEX G. CCITT-SPECIFIED DTE FACILITIES TO SUPPORT THE OSI NETWORK SERVICE

G.1 INTRODUCTION

The facilities described in this Annex 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. These facilities are passed unchanged between the two packet mode DTEs involved.

XI accepts any of the CCITT-specified DTE Facilities, and deliver them unchanged to the called DTE.

In general, an XI network does not act upon the content of DTE facilities, except for extended addressing facilities, when a virtual call is set up between a DTE attached to a PSDN and a DTE attached to an XI network. In this case, the called address extension facility needs to be in one of the two specific formats described in 5.8 (XI address formats)

Procedures for use of these facilities by DTEs require definition by international user bodies. Subsequent provision of X.25 facilities to be acted on by public data networks is for further study. Coding of the facilities in this Annex is defined here in order to facilitate a consistent facility coding scheme in such future evolution.

G.2 CODING OF THE FACILITY CODE FIELDS

Table G-1/X.25 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.

TABLE G-1/X.25

Coding of the Facility Code Field

Facility	Packet types which may be used in the facility						Facility code
	Call req.	Inc. call	Call accept.	Call conn.	Clear ind.	Clear req.	Bits 8 7 6 5 4 3 2 1
Calling address extension	X	X					1 1 0 0 1 0 1 1
Called address extension	X	X	X	X	X	X	1 1 0 0 1 0 0 1
Quality of service negotiation:							
minimum throughput class	X	X					0 0 0 0 1 0 1 0
end-to-end transit delay	X	X	X	X			1 1 0 0 1 0 1 0
Expedited data negotiation	X	X	X	X			0 0 0 0 1 0 1 1

G.3 CODING OF THE FACILITY PARAMETER FIELDS

G.3.1 Calling Address Extension Facility

The octet following the facility code field indicates the length in octets of the facility parameter field and has a value of n + 1, where n may be a maximum of 16 octets in order to hold the calling address extension.

The first octet of the facility parameter field indicates, in bits 6, 5, 4, 3, 2, and 1, the number of semi-octets (up to 32) in the calling address extension. This address length indicator is binary coded and bit 1 is the low-order bit. Bits 8 and 7 of this octet are set to zero.

The following octets (up to 16) contain the calling address extension.

Each digit of an address 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 in octets of the facility parameter field and has a value of n + 1, where n may be a maximum of 20 octets in order to hold the called address extension.

The first octet of the facility parameter field indicates, in bits 6, 5, 4, 3, 2 and 1, the number of semi-octets (up to 40) in the called address extension. This address length indicator is binary coded and bit 1 is the low-order bit. Bits 8 and 7 of this octet are set to zero if the called address extension is in OSI format (NSAP format), and are set to 10 otherwise.

The following octets (up to 20) contain the called address extension. The format of the address is described in 5.8.3.

Each digit of an address 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 indicating each throughput class are binary coded and correspond to throughput classes as indicated in Table 28/X.25.

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 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. The fifth and sixth octets are optional and, when present, contain the maximum acceptable 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.3.4 Expedited Data Negotiation Facility

The coding of the facility parameter field is:

Bit 1 = 0 for no use of expedited data
Bit 1 = 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.

ANNEX H. SUMMARY OF DIFFERENCES BETWEEN THE 1980 AND THE 1984 VERSIONS OF X.25

The following charts depict differences between the 1980 and 1984 versions of CCITT Recommendation X.25.

Legend:
- B - Base Function
- L - Limited
- O - Optional Function
- U - Unspecified
- N - Not Applicable

A. PHYSICAL LEVEL

Ref. #	Function		Version '80	'84
1.	X.21 Interface	*	B	O
2.	X.21-Bis Interface	*	L	O
3.	V-series Interface	**	N	O

* See other applicable 1984 CCITT Recommendations for possible incompatibilities.

** This interface is required for X.32. X.32 is a new recommendation for switched access to an X.25 network.

B. LINK LEVEL		
Ref. # Function	Version '80	'84
1. Phase-Synchronization	U	B
2. Initialization-Phase	U	B
3. Disconnection-Phase	U	B
4. DCE-Timer-T3 (Idle Channel Time-out)	N	O
5. I-frame-Rejection-Recovery	U	B
6. DTE-Data-Integrity Responsibility	U	B
7. Octet-Frame-Alignment	O	B
8. Modulo-128-Frame-Sequencing	N	O
9. Multilink-Procedure	N	O
10. Restricted-Flag-Sequences	O	B
11. DM-Response-Contention-Resolution	U	B
12. U-Command-Contention-Resolution	U	B

C. PACKET LEVEL		
Ref. # Function	Version '80	'84
1. Datagram-Services	O	N
2. Extended-Interrupt-User-Data	N	B
3. Single-Packet/Frame	U	B
4. Octet-Packet-Alignment	U	B
5. DCE-D-bit-Procedure	L	B
6. Network-Error-Reactions	U	B
7. Expanded-Diagnostic-Codes	O	B
8. Expanded-DTE-Cause-Codes	N	B
9. Expanded-Packet-Sizes	N	O
10. Expanded-Facility-Length	N	B
11. Expanded-Facilities-Field	N	B
12. Extended Clear-Request and Clear-Indication Formats	N	O
13. Extended Clear-Confirmation Formats	N	O

D. NEW OPTIONAL USER FACILITIES		
Ref. # Function	Version '80	'84
1. On-Line-Facility-Registration	N	O
2. Local-Charging-Prevention	N	O
3. Network-User-Identification	N	O
4. Charging-Information	N	O
5. Hunt-Group	N	O
6. Call-Redirection	N	O
7. Called-Line-Address-Modified-Notification	N	O
8. Call-Redirection-Notification	N	O
9. Transit-Delay-Selection-and-Indication	N	O

E. OPTIONAL USER FACILITY EXTENSIONS		
Ref. # Function	Version '80	'84
1. CUG Selection	N	O
2. CUG with Outgoing Access Selection	N	O
3. Absence of both CUG Selection-Facilities	N	O
4. No Preferred CUG	N	O
5. Bilateral CUG Selection	N	N
6. Extended RPOA Selection	N	O
7. Essential Fast Select	N	O

F. CCITT-SPECIFIED DTE FACILITIES		
Ref. # Function	Version '80	'84
1. x'0F'-Facility-Marker	N	O
2. Address-Extension	N	O
3. Minimum-Thru-put Class	N	O
4. Transit-Delay	N	O
5. Expedited-Data-Negotiation	N	O

H.1 LINK LEVEL

The references in parenthesis in this section refer to items in the relevant CCITT recommendation.

1. Disconnected Phase

   - 1984 - (2.4.4.1, 2nd paragraph) Introduces the concept of a 'Phase Synchronization' function whereby either the DTE or the DCE may transmit a DISC command, prior to initiation of the link set-up procedure, to ensure that the DTE and DCE are in the same (Disconnected) phase.

   - 1980 - Unspecified (subject to interpretation).

2. Link Set-Up

   - 1984 - (2.4.4.2, 5th paragraph) Introduces a 'Initialization Phase' wherein all frames except SABM/SABME and DISC command, or UA and DM responses, received following initiation of the link set-up procedure (for example, transmission or receipt of an SABM/SABME command) and prior to completion of that link set-up procedure (for example, receipt or transmission of an acknowledging UA) are explicitly ignored by the DTE or the DCE unless or until link set-up is aborted by the transfer of a DM response.

   - 1980 - Explicitly defines only a 'Disconnected Phase' and an 'Information Transfer Phase' (subject to interpretation).

3. Link Disconnection

   - 1984 - (2.4.4.3, 4th paragraph) Introduces a 'Disconnection Phase' wherein all frames except SABM/SABME commands, or UA and DM responses received following the initiation of the link disconnection procedure (for example, transmission or receipt of a DISC command) and prior to completion of the disconnection procedure (for example, receipt or transmission of an acknowledging UA or DM response) are explicitly ignored by the DTE or the DCE.

   - 1980 - Explicitly defines only a 'Disconnected Phase' and an 'Information Transfer Phase' (subject to interpretation).

4. DCE-Timer T3 (Idle Channel Time-out)

   - 1984 - (2.3.5.5) Defines a period T3 that DCEs, after detecting the 'Idle Channel State' condition, shall wait for detection of a return to 'Active Channel State' before signalling the condition to a higher level.

   - 1980 - Not Applicable.

5. I-frame Rejection Recovery

   - 1984 - (2.4.5.9, 8th paragraph) Specifically prohibits duplicate I-frame re-transmissions within the same numbering cycle.

   - 1980 - Ignores duplicate I-frame retransmissions.

6. Data Integrity Responsibility

   - 1984 - (2.3.4.5, 4th paragraph and 2.3.4.6, 2nd paragraph) Explicitly place responsibility for recovery from the possible loss of I-frame contents with a higher level.

   - 1980 - Undefined.

7. Octet Frame Alignment

   - 1984 - (2.3.5.3, 2nd paragraph) Explicitly allows <u>octet aligned networks</u> to ignore non-octet aligned frames as invalid.

   - 1980 - Undefined.

8. Frame Sequencing

   - 1984 - (2.4) Incorporates an <u>optional</u> extended mode wherein frame sequencing is performed modulo 128.

- 1980 - Limits frames sequencing to modulo 8.

9. Multilink

   - 1984 - (2.5) Incorporates optional procedures for control of multiple access links at a DTE/DCE interface.

   - 1980 - Limits DTE/DCE interfaces to single access link.

10. Restricted Flag Sequences

   - 1984 -(2.2.2, 2nd sentence) Restricts sequences of multiple flags transmitted to complete 8-bit flag sequences.

   - 1980 - Allows shared 0-bit flag sequences.

11. DM-Response Contention Situation

   - 1984 - (2.4.4.7) Explicitly places responsibility for resolution with the DTE.

   - 1980 - Undefined.

12. U-Command Contention Situation

   - 1984 - (2.4.4.5.1) Explicitly places responsibility for resolution with the DCE.

   - 1980 - Undefined.

H.2 PACKET LEVEL

1. Datagram Service

   - 1984 - Undefined.
   - 1980 - (5.0) Additional optional service.

2. Expanded Interrupt User Data

   - 1984 - (5.3.2.1 and Figure 7) Expands the length of the user data field in interrupt packets to a maximum of 32 octets (usage may be established by negotiation).
   - 1980 - Limited to exactly 1 octet.

3. Single Packet/Frame

   - 1984 - (3.0, 2nd paragraph) Explicitly limits the information field of I-frames to a single packet.
   - 1980 - Unresolved.

4. Octet Packet Alignment

   - 1984 - (3.0, 3rd paragraph and Note 1) User data field must be octet aligned.
   - 1980 - Unresolved.

5. D-bit Negotiation Procedure

   - 1984 - (4.3.3) Assumes full network support of the D bit procedures.
   - 1980 - Interim.

6. Network Error Reactions

   - 1984 - (3, 4, and 5 and Annex D) Clarifies DTE and DCE responses on time outs.
   - 1980 - Unresolved.

7. Expanded Diagnostic Codes

   - 1984 - (Annex E) Adds new diagnostic codes for 'Packet Not Allowed', 'Call Set-up, Call Clearing or Registration Problems', 'Miscellaneous' and 'International Problems'.
   - 1980 - Undefined.

8. DTE/DCE Cause Code

   - 1984 - (5.2.3.1.1, 2nd paragraph; Table 18; 5.4.3.1, 2nd paragraph; Table 19; and 5.5.1.1, 2nd paragraph) Assign values X'00' and <u>optionally ≥ X'80' for DTEs.</u>
   - 1980 - Limited to X'00' for DTE's.

9. User Data Field

   - 1984 - (4.3.2, 2nd paragraph) Accommodates new <u>optional</u> maximum user data field lengths of <u>2048 and 4096 octets.</u>
   - 1980 - Maximum User Data Field length limited to <u>1024 octets.</u>

10. Facility Length Field

    - 1984 - (5.2.1, Figure 2; 5.2.2, Figure 3; 5.2.3, Figure 4; and 5.2.4, Figure 5) Expanded to 8-bits with a maximum value of 109.
    - 1980 - Restricted to 6-bits with a maximum value of 63.

11. Facilities field

    In call-request, incoming-call, call-accepted and call-connected packets:

- 1984 - (5.2.1.6, 3rd paragraph and 5.2.2.1.5, 3rd paragraph) Length extended to accommodate up to 109 octets.

- 1980 - Length limited to 63 octets.

12. Address and facility lengths

    In Clear Request and Clear Indication:

- 1984 - (5.2.3.2 and Figure 4) Defines an optional extended format for use in conjunction with one or more optional user facilities.

- 1980 - Limited to X'00' and allowed only when clear user data field is included in the clear request or clear indication packet.

13. Clear Confirmation

- 1984 - (5.2.4 and Figure 5) Defines an optional extended format to accommodate clear user data for use only with the charging information facility.

- 1980 - Defines only a basic packet format with no user data field.

H.3 NEW OPTIONAL USER FACILITIES

1. Online Facility Registration
   - 1984 - (5.7.2, 6.1, Figure 17).
   - 1980 - Not defined.
2. Local Charging Prevention
   - 1984 - (6.20).
   - 1980 - Not defined.
3. Network User Identification
   - 1984 - (6.21).
   - 1980 - Not defined.
4. Charging Information
   - 1984 - (6.22).
   - 1980 - Not defined.
5. Hunt Group
   - 1984 - (6.24).
   - 1980 - Not defined.
6. Call Redirection
   - 1984 - (6.25).
   - 1980 - Not defined.
7. Called Line Address Modified Notification
   - 1984 - (6.26).
   - 1980 - Not defined.
8. Call Redirection Notification
   - 1984 - (6.27).
   - 1980 - Not defined.
9. Transit Delay Selection and Indication
   - 1984 - (6.28).
   - 1980 - Not defined.

H.4 OPTIONAL USER FACILITY EXTENSIONS

1. Closed User Group Selection

   (7.2.2.3.2) - Extended Format

   - 1984 - (6.14.6).
   - 1980 - Not explicitly defined.

2. CUG with Outgoing Access Selection

   (7.2.2.4.2) - Extended Format

   - 1984 - (6.14.7).
   - 1980 - Not explicitly defined.

3. Absence of Both CUG Selection Facilities

   - 1984 - (6.14.8).
   - 1980 - Not defined.

4. No Preferential CUG

   - 1984 - (6.14.2) Allows networks to offer the capability of choosing whether or not to have a preferential CUG.
   - 1980 - Not allowed.

5. Bilateral CUG Selection

   - 1984 - (6.15.3).
   - 1980 - Not explicitly defined.

6. RPOA Selection Facility Extensions

   (7.2.2.9.2) - Extended Format

   - 1984 - (6.23, 3rd paragraph).
   - 1980 - Not defined.

7. Essential Fast Select Facility

   - 1984 - (6.16) Assumes universal availability of the facility.
   - 1980 - Optional availability.

H.5 CCITT-SPECIFIED DTE FACILITIES

1. Facility Marker = X'0F'

   - 1984 (7.1, 15th paragraph and G.1).
   - 1980 - Not defined.

2. Address Extension

   - 1984 - (G.3.1 and G.3.2) - Option.
   - 1980 - Not defined.

3. Minimum Throughput Class Negotiation

   - 1984 - (G.3.3.1) - Option.
   - 1980 - Not defined.

4. Transit Delay Negotiation

   - 1984 - (G.3.3.2) - Option.
   - 1980 - Not defined.

5. Expedited Data Negotiation

   - 1984 - (G.3.4) - Option.
   - 1980 - Not defined.

APPENDIX I. EXAMPLES OF LINK LEVEL TRANSMITTED BIT PATTERNS BY THE DCE AND THE DTE

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

I.1

The following are examples of the bit patterns that will be transmitted for some unnumbered frames:

Example 1: SABM command frame with address A, P = 1

```
First bit transmitted                                          Last bit transmitted
|                                                                                 |
V                                                                                 V
0111 1110    1100 0000    1111 1(0[3])100     1101 1010 0011 0111       0111 1110
Flag         Address=A    SABM (P = 1)        Frame check sequence           Flag
```

Example 2: UA response frame with address B, F = 1

```
First bit transmitted                                          Last bit transmitted
|                                                                                 |
V                                                                                 V
0111 1110    1000 0000    1100 1110           1100 0001 1110 1010       0111 1110
Flag         Address=B    UA (F = 1)          Frame check sequence           Flag
```

I.2

The following are examples of the bit patterns that should be transmitted by a DTE for some unnumbered frames:

Example 1: SABM command frame with address B, P = 1

```
First bit transmitted                                          Last bit transmitted
|                                                                                 |
V                                                                                 V
0111 1110    1000 0000    1111 0(0[3])100     1101 0111 11(0[3])11 1011   0111 1110
Flag         Address=B    SABM (P = 1)        Frame check sequence           Flag
```

Example 2: UA response frame with address A, F = 1

```
First bit transmitted                                          Last bit transmitted
|                                                                                 |
V                                                                                 V
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

PART 2: REVISED RECOMMENDATION X.32

INTERFACE BETWEEN DATA TERMINAL EQUIPMENT (DTE) AND DATA CIRCUIT-TERMINATING EQUIPMENT (DCE) FOR TERMINALS OPERATING IN THE PACKET-MODE AND ACCESSING A PACKET SWITCHED PUBLIC DATA NETWORK THROUGH A PUBLIC SWITCHED TELEPHONE NETWORK OR A CIRCUIT SWITCHED PUBLIC DATA NETWORK

The establishing in various countries of Packet Switched Public Data Networks (PSPDN) providing data services creates the need to produce Recommendations to facilitate access to the PSPDN through a public switched telephone network (PSTN) or a circuit switched public data network (CSPDN).

The CCITT, considering:

a. that Recommendation X.1 specifies the user classes of service for DTEs operating in the packet-mode, that Recommendation X.2 defines user facilities provided by public data networks, that Recommendations X.10 defines categories of access, that Recommendations X.21 and X.21 bis define DTE/DCE physical level interface characteristics, that Recommendation X.25 defines the interface between DTE and DCE for terminals operating in the packet-mode and connected to public data networks by dedicated lines, that Recommendations X.121 defines the international numbering plan for Public Data Networks (PDN), that Recommendation X.300 defines the principles and arrangements for interworking between PDNs and other public networks;

b. that the V-series Recommendations define modem and interface characteristics for use of data services on the PSTN;

c. that Recommendation T.70 defines the procedures and interfaces to be used by Telematic terminals, that Recommendation T.71 defines the extension of Link Access Procedure Balanced (LAPB) procedure to be used in half-duplex transmission facilities (LAPX);

d. that a need has been identified to access a PSPDN through a PSTN or CSPDN, either because a dedicated circuit to the PSPDN is not justified or because global service availability is required with back-up network access via public switched networks;

e. that some Administrations have considered the provision of Telematic services in different types of networks, e.g., PSPDN, PSTN and CSPDN;

f. that, when this Recommendation is used to provide the Network service defined in Recommendation X.123, the physical, link and packet levels correspond to the Physical, Data link and Network layers respectively, as defined in Recommendation X.200;

(unanimously) declares the view

that the functional and procedural aspects of packet-mode DTEs accessing a PSPDN through a PSTN or CSPDN are as specified in this Recommendation.

1. SCOPE

This Recommendation defines the functional and procedural aspects of the DTE/DCE interface for packet-mode user classes of service DTEs as defined in Recommendations X.1 and X.10 for DTEs that access a PSPDN via public switched networks. In this Recommendation, a public switched network (PSN) is either a Public Switched Telephone Network (PSTN) or a Circuit Switched Public Data Network (CSPDN).

| **Note:** Only PSTN is applicable to XI

In the PSTN case, the X.32 DTE/DCE interface coincides with the interface between the DTE and the modem. This definition applies whether or not the Administration provides the DCE and regardless of how the interface is physically realized (e.g., whether or not the DTE and DCE are contained within the same enclosure). In either case, the PSN is involved only:

a. in the establishment of the switched access path;

b. to provide a transmission medium; and

c. optionally, to provide a PSN number for purposes of identification and addressing.

Administrations may offer one or more of the following physical level interfaces:

1. For access by way of a CSPDN, either Recommendation X.21 or Recommendation X.21 bis will be used, as described in 4.1 or 4.2, respectively.

| XI does not support X.21 switched interface

2. For access by way of PSTN, appropriate V-series Recommendations will be used as described in 4.3.

The exact use of the relevant points in these Recommendations is given in 4.

| Only duplex transmission facilities are supported by XI

At the link level, the LAPB link access procedure of Recommendation X.25 is used over a single switched physical circuit. The LAPB formats and procedures shall be in accordance with 2.2, 2.3, and 2.4 of Recommendation X.25, with additions as noted in 5 of this Recommendation.

The formats and the procedures at the packet level shall be in accordance with sections 3, 4, 5, 6, and 7 of Recommendation X.25 with the additions noted in 6 of this Recommendation.

2.1 DIAL-IN AND DIAL-OUT CONSIDERATIONS

Dial-in operation allows a packet-mode DTE to access a PSPDN by means of selection procedures on a PSTN or CSPDN (see Figure 1). This operation is termed "dial-in-by-the-DTE" within this Recommendation.

In the XI environment, "dial-in by the DTE" is referred to as Switched Network Access Facility (SNAF)

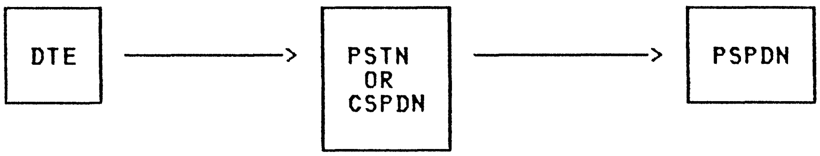


Figure 1. X.32 Dial-in-by-the-DTE operation

For performing this operation, the DTE may use an automatic or manual calling procedure.

Dial-out operation allows a PSPDN to access a packet-mode DTE by means of selection procedures on a PSTN or CSPDN (see Figure 2). This operation is termed "dial-out-by-the PSPDN" within this Recommendation.

In the XI environment, "dial-out by the PSDN" is used for DTE access line back-up which is referred to as Switched Network Back-Up (SNBU).

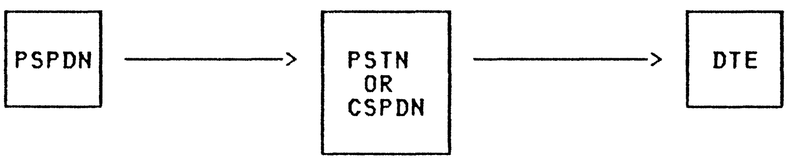


Figure 2. X.32 Dial-out-by-the-PSPDN operation

For dial-out-by-the-PSPDN operation, the DTE should use the automatic answering but may use manual answering.

Virtual call origination is independent of dial-in-by-the-DTE and dial-out-by-the-PSPDN operations. That is, a DTE that has been involved in a dial-in-by-the-DTE or dial-out-by-the-PSPDN operation may then initiate or receive virtual calls, subject to the limitations in specific situations as described in 3.

2.2 IDENTIFICATION

2.2.1 DTE Identity

When a DTE accesses a PSPDN through a PSN (dial-out-by-the-PSPDN), there may be a requirement for identification of the DTE to the DCE.

Identification of the DTE to the DCE is required by XI for SNBU operation. It is not required for SNAF operation.

The DTE "identity" is a means of referring to the DTE. The DTE identity is either explicitly agreed to between the DTE and the Administration or is implicitly acceptable to the Administration through agreements with other Administrations, organizations, or authorities. It may be composed of different elements such as a number from a numbering plan, identification of the DTE service and authority, validity dates and period, public keys used for authentication, etc.

| In SNBU, the DTE identity is agreed upon with the network service provider. The DTE identity is composed of a number (XI home DTE address) in the XI addressing scheme.

The characteristics of the service which a DTE obtains via dial-in-by-the-DTE or dial-out-by-the-PSPDN access depend upon whether the PSPDN considers the DTE identified for each particular switched access connection or virtual call. If the DTE is identified, then the PSPDN has a way to accrue charges to be paid on behalf of the DTE. That is, either the DTE or some other party is billable.

Two components are required in order for a DTE to be considered identified:

1. The DTE is administratively registered either:

    a. through direct arrangement with the PSPDN (i.e., explicitly), or

    b. through pre-arrangement between the PSPDN and a PSN or another authority, and direct arrangement between the DTE and that authority (i.e., not explicitly).

2. The DTE identify is made known to the DCE during the switched access connection using one of the methods described in 2.4.

| Only case 1-a is applicable to XI.

A DTE may incur charges even if not identified because some Administrations collect charges via the PSTN or CSPDN.

| This type of charging is not applicable to XI

In any case, DTE identification is used for billing and accounting purposes. In addition to this basic function, DTE identification may optionally be used for one or both of the following purposes:

a. enabling the PSPDN to provide a calling DTE address to a called DTE or

b. enabling the DTE to obtain a different service than that offered to DTEs which do not establish an identity (see 2.3).

2.2.2 DCE Identity

When a network supports dial-out-by-the-PSPDN access to DTEs, there may be a requirement for identification of the network (i.e., DCE) to the DTE. In the case of dial-in-by-the-DTE access, although the identity of the DCE may already be known by the DTE (as the DTE originated the switched access connection), there may be a DTE requirement for identification of the network.

| DCE identity is not required for SNAF and SNBU operation.

2.3 SERVICE ASPECTS

The switched access service given to a particular DTE is dependent upon:

a. The PSPDN,

b. The use/non-use of DTE identification, and

c. The DTE service available to and chosen by the DTE.

Three DTE service types are defined in this Recommendation (see 2.3.2). One of the DTE service types (Nonidentified) is independent of the specific DTE identity. One service type (Identified) may or may not be independent of the specific DTE identity. The third type (Customized) is related to the specific DTE identify in order to provide customization of some service aspects.

The types of DTE service are further distinguished by whether there is a number assigned by the network to be used to represent the DTE identify in the address fields of call set-up packets. This number is called a "registered address" and is defined in 3.1.3.

2.3.1 Service Attributes

"Attributes" are defined to describe each aspect of switched access service. However, the values of the attributes do not necessarily include all capabilities offered to PSPDN users that access the PSPDN via a leased line. The attributes are:

1. DTE identity,
2. DTE identification method,
3. Registered address,
4. Registered PSN number,
5. X.25 subscription set,
6. Logical channels assignment,
7. Dial-out-by-the-PSPDN availability,
8. Modem selection,
9. Temporary location,
10. Secure dial-back,
11. DCE identity presentation, and
12. Link level address assignment.

For each DTE service, each attribute either:

1. Is not provided or
2. Is provided and either:
    a. is set to a default value specified by the network (Network Default) or
    b. is set to a value selected by the user from a set of values provided by the network (User Selectable).

    Note: A network may define a default value for the attribute.

A "DTE profile" is the set of values of the Network Default and User Selectable attributes that have been selected for a particular DTE identity.

Note: The DTE profile need not be stored in the PSPDN.

Some networks may allow a subscriber to arrange for more than one DTE profile to meet different requirements for switched access service. Each DTE profile is independent. A "DTE profile designator" is used to differentiate the multiple profiles of the DTE.

For SNBU operations, each DTE has its own DTE profile, which is the one used for normal operations on the leased line. For SNAF operation, each XI network may offer more than one DTE profile; each DTE profile is a function of the PSTN number to be used by the DTE for access to one of the DCE ports of the XI network.

2.3.2 DTE Services

Some networks may offer service to unidentified DTEs; that is, to DTEs for which no identification is provided to the DCE.

This applies to the SNAF mode of operation of XI.

Some networks may offer service to identified DTEs, that is, to DTEs for which an implicit or explicit DTE identity is provided to the DCE via one of the methods specified in 2.4. Different types of service are defined for use in different situations. The network may offer one or more of these services.

| This applies to the SNBU mode of operation of XI, though none of the identification | methods described in 2.4 applies to XI.

The three types of service defined in this Recommendation are called DTE services. One is a service for unidentified DTEs. The other two are services for identified DTEs. The three DTE services are:

a. Nonidentified,

b. Identified, and

c. Customized.

2.3.2.1 Service for Unidentified DTEs

The service offered to unidentified DTEs is called "nonidentified" DTE service and is detailed in 3.3. This DTE service may be offered as part of dial-in-by-the-DTE or dial-out-by-the-PSPDN operation or both.

| For XI, this service applies only to dial-in-by-the-DTE operation (SNAF mode of | operation).

For a dial-in-by-the-DTE operation, the switched access path shall not be disconnected for a period of time (T14) even in, the absence of any virtual calls. This allows users a period of time to reestablish a virtual call. See 7.5.

For dial-in-by-the-DTE operation, the PSPDN may limit the number of unsuccessful attempts to establish a virtual call.

| This limitation is not implemented by XI.

| When a DTE uses the SNAF service, it is not required to use any optional procedures.

2.3.2.2 Services for Identified DTEs

The services offered to identified DTEs provide a set of capabilities/facilities different from and/or enhanced beyond the nonidentified DTE service.

Identified

| XI does not offer the "identified" DTE service.

Customized

The PSPDN may offer the "customized" DTE service in which the DTE identity has been explicitly agreed to with the Administration, a registered address has been allocated and the other attributes are set according to the DTE profile which has been customized for the DTE according to the capabilities supported by the network as permitted within the specification given in 3.5. The effect is that this DTE is billable, has an X.121 address registered with the PSPDN, and is provided a service tailored in many aspects to its requirements. This DTE service may be offered as part of dial-in-by-the-DTE or dial-out-by-the-PSPDN operation or both.

| XI offers this service only for dial-out-by-the DTE (SNBU) mode of operation.

2.4 DTE IDENTIFICATION METHODS

2.5 DCE IDENTIFICATION METHODS

| Not applicable in the XI environment.

2.6 DIAL-IN-BY-THE-DTE AND DIAL-OUT-BY-THE PSPDN OPERATION

All PSPDNs conforming to this Recommendation shall provide dial-in-by-the-DTE operation. Provision of dial-out-by-the-PSDN operation is optional.

| XI provides dial-out-by-the PSDN for back-up (SNBU) mode of operation.

2.7 DTE SERVICE REQUIREMENT

To provide a switched access service to DTEs, without introducing additional procedures, all PSPDNs conforming to this Recommendation shall offer the nonidentified DTE service and/or support use of the provided-by-the-PSN DTE identification method.

| XI offers the nonidentified DTE service with SNAF mode of operation.

2.8 DUPLEX AND HALF-DUPLEX OPERATION

If CSPDN access is used, the transmission facility is duplex. If PSTN access is used, the transmission facility operation is duplex, or optionally, some networks may also provide for half-duplex operation. The additional procedures necessary for half-duplex operation are described in 5.6.

| XI only supports PSTN access, in duplex mode.

2.9 IDENTIFICATION PROTOCOL

| Not applicable in the XI environment.

2.10 NEGOTIATION OF VALUES

Presently, DCE parameters are set to specific values according to the DTE profile as outlined in 2.3 and 3.

3.1 DTE SERVICE ATTRIBUTES

3.1.1 DTE Identity

The "DTE identity" attribute, when provided, defines the identity of the DTE.

3.1.2 DTE Identification Method

Not applicable in the XI environment.

3.1.3 Registered Address

The "registered address" is a number assigned by the PSPDN to the DTE to be used to represent the DTE identity in the address fields of call setup packets, when a DTE identity is directly agreed to (see 2.3).

When a registered address is provided, the "registered address" attribute defines the number allocated by the PSPDN to the DTE.

With XI, the registered address is a number (or a set of numbers if subaddressing is used) valid in the XI addressing scheme.

3.1.3.1 Registered Address Not Provided

When a registered address is not provided, the value given in the address field of a call set-up packet is discussed below.

In the case of dial-in-by-the-DTE, when the DTE makes a call request, the contents of the calling address field in the corresponding Incoming Call packet are as shown in Table 1/X.32.

TABLE 1/X.32

Calling address field content when a registered address is not provided

Calling DTE		Calling address field content
Nonidentified - see 2.3.2.1		Temporary number from the PSDN numbering plan (Note 3)

Note 3

If the temporary number is used, the called DTE must be made aware that the contents of the calling address field is not a DTE address. The means to convey this information are for further study. Pending the results of such a study, this option may be used nationally, but such a temporary number shall not be carried on international interconnection.

With XI, the dialing DTE is temporarily assigned the address of the port it has dialed. The format of the calling address field is the same as in the case of leased access.

3.1.3.2 Registered Address Provided

In those cases when a registered address is provided, its use is described below.

When an identified DTE makes a call request, the calling DTE address included in the Incoming Call packet given to the called DTE is the registered address.

Upon receiving a call request with a called DTE address, that is the registered address, the PSPDN needs to determine whether or not to perform a dial-out-by-the-PSPDN operation. If there is a switched connection in existence on which the DTE identity that corresponds to the registered address has been established, that switched connection will be used by the PSPDN. Otherwise, the PSPDN will perform the dial-out-by-the-PSPDN operation.

For SNBU , switched connection is established through network operator commands. If this connection has not been previously established, calls addressed to this DTE are cleared.

The PSN number used for the dial-out-by-the-PSPDN is the registered address.

3.1.4 Registered PSN Number

When the "registered PSN number" attribute is provided, its value is used by the PSPDN for dialing out to that DTE.

3.1.5 X.25 Subscription Set

The "X.25 subscription set" attribute defines values for the X.25 link level options and system parameters and the X.25 packet level subscription-time optional user facilities which apply to switched access operation. Networks are not required to support all of the link level options and packet level subscription-time facilities, except as required in Recommendation X.2. The list of link level options and system parameters and packet level optional user facilities in the X.25 subscription set is given in Table 4/X.32 (see 3.3).

Note: As defined in Recommendation X.25, the throughput class value is, at most, the speed of the access line (see the modem selection attribute, 3.1.8). However, in the case of a modem with automatic fall-back capability, the DCE shall set the default throughput class value to the maximum signalling rate of the modem used, unless the user has selected a lower value for the default throughput classes assignment facility. Whether some networks may take into account the signalling rate selected by the modems in fixing the default throughput class, if it is technically possible for the DCE to be aware of this rate, is left for further study.

XI does not automatically adapt the throughput class to the signalling rate when the modem moves from normal to fall-back speed.

3.1.5.1 Network Default

Not applicable in the XI environment.

3.1.5.2 User Selectable

When the X.25 subscription set is specified as user selectable, the value of each of the options, parameters, and facilities is available for customization by the user to a value from the set of values offered by the PSPDN.

In SNAF mode of operation, the X.25 subscription set is a function of the PSTN number dialed by the DTE.

3.1.6 Logical Channels Assignment

The "logical channels assignment" attribute defines the number of logical channels of each type assigned for a particular DTE.

There is a default value assigned by the PSPDN for nonidentified DTEs (see below).

3.1.6.1 Network Default

| Not applicable in the XI environment.

3.1.6.2 User Selectable

When the logical channels assignment is specified as user selectable, the number of logical channels of each type is set by the user, for the particular DTE identity, from the values supported by the network. This may include the assignment of channels for permanent virtual circuits.

| In SNAF mode of operation, logical channels assignment is a function of the PSTN number dialed by the DTE.

| PVC service is available in SNAF and SNBU mode of operation.

3.1.7 Dial-out-by-the-PSPDN Availability

The "dial-out-by-the-PSPDN availability" attribute allows the use of dial-out-by-the-PSPDN operation.

3.1.7.1 Network Default

| Not applicable in the XI environment.

3.1.7.2 User Selectable

When the dial-out-by-the-PSPDN availability is specified as user selectable, the capability to have dial-out-by-the-PSPDN operation with a particular DTE is chosen by the user. When the dial-out-by-the-PSPDN availability is selected, the registered PSN number attribute must also be selected.

| With XI, this applies only to SNBU mode of operation

| For SNBU , switched connection is established through network operator commands. If this connection has not been previously established, calls adressed to this DTE are cleared.

3.1.8 Modem Selection

The "modem selection" attribute applies to dial-out-by-the-PSPDN operation and allows a DTE to choose modem characteristics or a user class of service, possibly other than the national default, from those offered by the network. Modem selection refers to the modem characteristics (in the case of the PSTN) or the X.1 user class (in the case of the CSPDN) that are used for switched access line operation at the physical level. See 4. Note that for dial-in-by-the-DTE through the PSTN, the modem characteristics of the PSPDN port dialed into are used.

3.1.8.1 Network Default

| Not applicable in the XI environment.

3.1.8.2 User Selectable

When the modem selection is specified as user selectable, the modem characteristics selected for this DTE identity, from those offered by the network, are used for dial-out-by-the-PSPDN through the PSTN.

| With XI, modem and port selection are performed by the network operator.

3.1.9 Temporary Location

| Not applicable in the XI environment.

3.1.10 Secure Dial-Back

| Not applicable in the XI environment.

3.1.11 DCE Identity Presentation

| Not applicable in the XI environment.

3.1.12 Link Level Address Assignment

The "link level address assignment" attribute defines the mechanism used to determine the link level addresses.

Note: Other methods of link level address assignment than those described below are for further study.

3.1.12.1 Network Default

| XI assigns the link level address depending on the roles of equipment as DTE or DCE.
| XI always acts as a DCE.

3.1.12.2 User Selectable

| Not applicable in the XI environment.

3.2 DTE SERVICES SUMMARY

The type of each attribute is given for the three DTE services in Table 3/X.32.

TABLE 3/X.32

Summary of DTE services.

SERVICES / ATTRIBUTES	NONIDENTIFIED (SNAF)	CUSTOMIZED (SNBU)
DTE identity	---	Yes
Registered address	---	Yes
Registered PSN number	---	User sel.
X.25 subscription set	User sel. (*)	User sel.
Logical channel assignment	User sel. (*)	User sel.
Dial-out-by-the-PSPDN availability	---	User sel.
Modem selection	User sel. (*)	User sel.
Link level address assignment	ND (DTE/DCE role)	ND (DTE/DCE role)

--- : not provided
ND : Network Default
User sel.: User selectable (subscription time)
Yes : Provided

(*) In SNAF mode of operation, XI offers a set of DTE services equivalent to the non-identified service. Selection of one of the DTE services is done through dial-in to the appropriate port (or group of ports), specified by a PSTN number. The network service provider may elect to assign the same profile of DTE services to all dial-in ports, thus achieving ND-type DTE services.

3.3 NONIDENTIFIED DTE SERVICE

The values of the attributes for the nonidentified DTE service defined in 2.3.2.1 are shown in the "nonidentified" column of Table 3/X.32.

No DTE identity is established.

No DTE identification method is used.

The X.25 link level options and system parameters and the X.25 subscription-time optional user facilities are categorized for dial-in-by-the-DTE and dial-out-by-the-PSPDN operation in Table 4/X.32 as:

- An "AVAIL-OPT" optional user facility, which is available on some networks offering the nonidentified DTE service and the availability of which is made known through either publication or use of the on-line facility registration facility; these facilities can be used without further request when operating on these networks.

  The use of this option, or the specific values attached to it, is selected according to the PSTN number of the SNAF port dialed.

The DTE may use any per-call X.25 facility that is supported by the PSPDN and that does not require prior subscription.

TABLE 4/X.32 (part 1 of 2)

Availability of link level options and system parameters and packet level subscription-time facilities in the nonidentified DTE service (applies to SNAF mode of operation)

Option, Parameter or Facility (application to all assigned logical channels)	Available with Dial-in-by-the-DTE operation
LINK LEVEL	
K	AVAIL-OPT
T1	AVAIL-OPT
N1	AVAIL-OPT
N2	AVAIL-OPT
PACKET LEVEL	
Extended Packet Sequence Number.	AVAIL-OPT
Incoming Calls Barred	AVAIL-OPT
Outgoing Calls Barred	AVAIL-OPT
One-way Logical Channel Outgoing	AVAIL-OPT
One-way Logical Channel Incoming	AVAIL-OPT
Permanent Virtual Circuit	AVAIL-OPT
Direct call	AVAIL-OPT
Nonstandard Default Packet Sizes	AVAIL-OPT
Nonstandard Default Window Sizes	AVAIL-OPT

TABLE 4/X.32 (part 2 of 2)

Option, Parameter or Facility (application to all assigned logical channels)	Available with Dial-in-by-the-DTE operation
PACKET LEVEL (continued)	
Default Throughput Classes Assignment	AVAIL-OPT
Flow Control Parameter Negotiation - subscription-time	 AVAIL-OPT
Closed User Group Related Facilities - Closed User Group - Closed User Group with Outgoing Access - Closed User Group with Incoming Access - Incoming Calls Barred within a Closed User Group - Outgoing Calls Barred within a Closed User Group	 AVAIL-OPT AVAIL-OPT AVAIL-OPT AVAIL-OPT AVAIL-OPT
Option, Parameter or Facility (application to all assigned logical channels)	Available with Dial-in-by-the- - DTE operation
Reverse Charging Acceptance	AVAIL-OPT
Call Redirection	AVAIL-OPT
Call Transfer	AVAIL-OPT

3.4 IDENTIFIED DTE SERVICE

Not applicable in the XI environment.

3.5 CUSTOMIZED DTE SERVICE

The values of the attributes for the customized DTE service (defined in 2.3.2.2) are shown in the "customized" column in Table 3/X.32.

A DTE identity that has been explicitly agreed to with the PSPDN for obtaining the customized DTE service is provided to the PSPDN.

The availability for customization of each X.25 link level option and system parameter and X.25 packet level subscription-time facility is given in Table 5/X.32.

TABLE 5/X.32 (part 1 of 2)

Availability for customization in the customized DTE service of the X.25 link level options and system parameters and the X.25 subscription-time facility (applies to SNBU mode of operation)

Option, Parameter or Facility	Customization Available
Link Level	
k	CUSTOM
T1	CUSTOM
N1	CUSTOM
N2	CUSTOM
Packet Level	
Extended Packet Sequence Numbering	CUSTOM
Incoming Calls Barred	CUSTOM
Outgoing Calls Barred	CUSTOM
One-way Logical Channel Outgoing	CUSTOM
One-way Logical Channel Incoming	CUSTOM
Permanent Virtual Circuits	CUSTOM
Direct call	CUSTOM

TABLE 5/X.32 (part 2 of 2)

Option, Parameter or Facility	Customization Available
Packet Level (continued)	
Nonstandard Default Packet Sizes	CUSTOM
Nonstandard Default Window Sizes	CUSTOM
Default Throughput Classes Assignment	CUSTOM
Flow Control Parameter Negotiation - Subscription-time	 CUSTOM
Closed User Group Related Facilities - Closed User Group - Closed User Group with Outgoing Access - Closed User Group with Incoming Access - Incoming Calls Barred within a Closed User Group - Outgoing Calls Barred within a Closed User Group	 CUSTOM CUSTOM CUSTOM CUSTOM CUSTOM
Reverse Charging Acceptance	CUSTOM
Call Redirection	CUSTOM
Call transfer	CUSTOM

CUSTOM: can be chosen or set to a nondefault value by the DTE, if supported by the PSPDN.

The DTE may use any per-call X.25 facility which is supported by the PSPDN and which does not require prior subscription.

The DTE may use any per-call X.25 facility which is supported by the PSPDN and which requires a corresponding subscription-time facility to be selected, provided that the corresponding subscription-time facility has been selected.

4. INTERFACE CHARACTERISTICS (PHYSICAL LEVEL)

Administration may offer one or more of the physical level interfaces specified below.

4.1 X.21 INTERFACE

| Not applicable in the XI environment.

4.2 X.21BIS INTERFACE

| Not applicable in the XI environment.

4.3 V-SERIES INTERFACE

For establishment, maintenance, and disestablishment of a switched access path between a DTE and a PSPDN by way of a PSTN, the physical level interface shall be as described in the following points of this section.

4.3.1 Modem Characteristics

Administrations may choose to offer modem characteristics in accordance with any or all of the following:

a. 1200 bit/s — V.22, alternatives A, B or C, mode (i)

b. 2400/1200 bit/s — V.22 bis, modes (i) or (iii), or V.26 ter, modes (i) or (iii)

c. 9600/4800 bit/s — V.32

| This list of modems is applicable to SNAF mode of operation. They can be used also for back-up of DTE leased lines through the PSTN, if they are equipped with back-up features. For full support by XI of the SNBU mode of operation, IBM modems of the 586x family (5865/5866 models 2 and 3), equipped with a 4-wire PSTN coupler, are required. These IBM modems can also be used for SNAF operations.

4.3.2 Procedures for Full Duplex Operational Phases

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

Circuits 106 and 109 may enter the OFF condition due to momentary transmission failures or modem retraining. Higher layers should delay for several seconds before considering the interface to be non-operational.

4.3.3 Procedures for Half Duplex Operational Phases

| Not applicable in the XI environment.

4.3.4 Origination Procedures

For SNAF operations, DTEs may use either:

a. The Automatic origination procedures described in 3 of Recommendation V.25;

b. The automatic origination procedures described in 4 or 5 of Recommendation V.25 bis

c. The manual origination procedures of 6 of Recommendation V.25.

d. The origination procedure of 586x modems

For SNBU operations, XI will use the automatic origination procedure of the 586x IBM modems, equipped with a 4-wire coupler.

Other origination procedures may be used, either manually or through external autocall equipment. XI does not provide specific support for these procedures.

4.3.5 Answering Procedures

For dial-out-by-the-PSPDN procedures, DTEs should use the automatic answering procedures of the 586x IBM modems.

If other V-series modems are used instead, DTEs should use the automatic answering procedures of Recommendations V.25 or V.25 bis.

For dial-in-by-the-DTE, networks will use automatic answering procedures only.

4.3.6 Disconnection Procedures

DTEs and networks shall use the disconnection procedures specified in Recommendation V.24.

4.3.7 Test Loops

The definitions of test loops and the principles of maintenance testing using test loops are provided in Recommendation V.54.

Descriptions of the test loops and the procedures for their use are given in the appropriate modem Recommendations. It should be noted that the procedures for loop testing vary among the several modem Recommendations.

XI does not support V.54 loop setting.

When using IBM 586x modems, the Line Problem Determination Aid (LPDA2) capabilities of these modems can be used for lines and modems diagnostic purposes

Automatic activation by a DTE of test loops 2 and 4 in the DCE at the remote terminal is not possible.

5. LINK ACCESS PROCEDURES ACROSS THE DTE/DCE INTERFACE

5.1 INTRODUCTION

This section specifies the mandatory and optional link level procedures that are employed to support switched access data interchange between a DCE and a DTE.

5.1.1 Compatibility with the ISO Classes of Procedures

The switched access link level procedures defined in this Recommendation use the principles and terminology of the High-level Data Link Control (HDLC) procedures specified by the International Organization for Standardization.

DCE compatibility of operation with the ISO balanced classes of procedures (Class BA with options 2 and 8 Class BA with options 2, 8 and 10) is achieved using the LAPB procedure described in 2.2, 2.3, and 2.4 of Recommendation X.25. Class BA with options 2 and 8 (LAPB modulo 8) is available in all networks for switched access.

5.1.2 Underlying Transmission Facility

| The underlying transmission facility is duplex only.

5.2 LINK LEVEL ADDRESS ASSIGNMENT

Two alternative mechanisms for assigning the link level addresses are included in the procedures of this Recommendation. The conditions when each mechanism applies are specified in the link level address assignment attribute (see 3.1.12).

| Only address assignment depending upon the DTE/DCE role is offered by XI.

5.2.1 Depending on Switched Access Call Direction

| Not applicable in the XI environment.

5.2.2 Depending on Roles of Equipment as DTE and DCE

In accordance with the specifications in 2.4.2 of Recommendation X.25, the link level address assignment depends on the roles of the equipment as DTE and DCE such that the DCE transmits to the DTE the address A in command frames and the address B in response frames and the DTE does the opposite (i.e., transmits to the DCE address B in command frames and address A in response frames).

5.3 USE OF XID FRAMES

| Not applicable in the XI environment.

5.4 LINK SET-UP AND DISCONNECTION

5.4.1 Link Set-Up

The initiative of the link set-up is in the charge of the DTE in dial-in-by-the-DTE operation and of the DCE in dial-out-by-the-PSPDN operation. The DCE may also initiate link set-up in the case of dial-up-in-by-the-DTE operation; likewise, the DTE may also initiate link set-up in the case of dial-out-be-the-PSPDN operation.

With XI, the link set-up (that is, transmission of an SABM command), is always initiated by the DTE.

During the period between transmitting an SABM command and receiving the UA response, the DCE/DTE shall discard any frame except SABM, Disconnect (DISC), Unnumbered Acknowledge (UA) and Disconnected Mode (DM) as specified in 2.4.4.1 of Recommendation X.25.

5.4.2 Disconnection

Whenever the DCE needs to disconnect the switched access path and the link is not already in the disconnected phase, it should first disconnect the link.

5.5 MULTILINK

Not applicable in the XI environment.

5.6 HALF-DUPLEX OPERATION

Not applicable in the XI environment.

6.1 SCOPE AND FIELD OF APPLICATION

The formats and the procedures at the packet level shall be in accordance with 3, 4, 5, 6, and 7 of Recommendation X.25 with additions as noted in this section and in 7 of this Recommendation.

6.2 USE OF REGISTRATION PACKETS FOR IDENTIFICATION OF DTE AND/OR DCE AND FOR CONVEYANCE OF X.32 OPTIONAL USER FACILITIES

| Not applicable in the XI environment.

6.3 IDENTIFICATION AND AUTHENTICATION OF THE DTE USING THE NUI FACILITY IN CALL SET-UP PACKETS

| Not applicable in the XI environment.

7. X.32 PROCEDURES, FORMATS, AND FACILITIES

7.1 IDENTIFICATION PROTOCOL

Not applicable in the XI environment.

7.2 PROCEDURES FOR X.32 OPTIONAL USER FACILITIES

Not applicable in the XI environment.

7.3 CODING OF THE IDENTIFICATION PROTOCOL ELEMENTS AND X.32 FACILITIES

Not applicable in the XI environment.

7.4 SECURITY GRADE 2 METHOD

Not applicable in the XI environment.

7.5 DCE TIMER T14

The DCE may support a timer T14, the value of which should be made known to the DTE.

At the expiration of timer T14, the DCE will disconnect directly the switched access path.

Timer T14 is started whenever a switched access path is established. Timer T14 is stopped when a virtual call(s) is established. The definition of a PVC or DC on the switched access path causes T14 not to be started.

Timer T14 will be restarted when no assigned logical channels are active.

The period of timer T14 shall be network dependent.

For XI, T14 is optional, and can be set by the network service provider from 10 to 180 seconds.

7.6 DCE TIMER T15

Not applicable in the XI environment.

APPENDIX A. ACTIONS TAKEN BY THE QUESTIONING AND CHALLENGED PARTIES

| Not applicable in the XI environment.

APPENDIX B. ABBREVIATIONS

AVAIL-BAS	Available on all networks
AVAIL-NS	Available and selected by the network
AVAIL-OPT	Available on some networks
AVAIL-RQ	Available on some networks and must be requested
BA	Class of HDLC
CSPDN	Circuit Switched Public Data Network
CUSTOM	Customized
DCE	Data Circuit-terminating Equipment
DIAG	Diagnostic element
DISC	Disconnect
DM	Disconnected Mode
DNIC	Data Network Identification Code
DSE	Data Switching Equipment
DTE	Data Terminal Equipment
FI	Format Identifier
HDLC	High-level Data Link Control
HDTM	Half-duplex Transmission Module
ID	Identity element
ISDN	Integrated Services Digital Network
ISO	International Organization for Standardization
K	Number of outstanding I frames
LAPB	Link Access Procedure B
LAPX	Link Access Procedure - Half-duplex
MT...	Parameter....
N...	Parameter....
ND	Network Default
NN	National Number
NTN	Network Terminal Number
NUI	Network User Identification
PDN	Public Data Network
PSN	Public Switched Network
PSPDN	Packet Switched Public Data Network
PSTN	Public Switched Telephone Network
RAND	Random Number element
REJ	Reject

RPOA	Recognized Private Operating Agency
RR	Receive Ready
RSA	Rivest, Shamir and Adleman algorithm
SABM	Set Asynchronous Balanced Mode
SABME	Set Asynchronous Balanced Mode Extended
SIG	Signature element
SRES	Signed Response element
TCC	Telephone Country Code
T...	Timer...
UA	Unnumbered Acknowledge
UTC	Coordinated Universal Time
XC...	Counter...
XID	Exchange Identification (Unnumbered Format)
XT...	Timer...

APPENDIX C. IMPLEMENTATION OF LAPX

| Not applicable in the XI environment.

APPENDIX D. RSA PUBLIC KEY ALGORITHM

| Not applicable in the XI environment.

APPENDIX E. RELATIONSHIP OF T14 TO THE DIFFERENT METHODS OF DTE IDENTIFICATION

| Not applicable in the XI environment.

The following terms are contained in this Recommendation. References to definitions, implicit or explicit, are included where appropriate and where available.

Authentication: cont. in X.32, impl. def. in X.32

Challenged party: cont. in X.32, impl. def. in X.32
Closed User Group: cont. in X.32, impl. def. in X.25
Counter: cont. in X.32, impl. def. in X.32
Customized DTE service: cont. in X.32, impl. def. in X.32

Data Network Identification Code: cont. in X.32, impl. def. in X.121
Dial-in-by-the-DTE: cont. in X.32, impl. def. in X.32
Dial-out-by-the-PSPDN: cont. in X.32, impl. def. in X.32
DCE identity: cont. in X.32, impl. def. in X.32
DTE identity: cont. in X.32, impl. def. in X.32
DTE profile: cont. in X.32, impl. def. in X.32
DTE service type: cont. in X.32, impl. def. in X.32

Exchange identification: cont. in X.32, impl. def. in X.32

Failure detection: cont. in X.32, impl. def. in X.21, impl. def in X. 21 bis

Half-duplex transmission module: cont. in X.32, impl. def. in X.32
High-level Data Link Control: cont. in X.32, impl. def. in X.25

Identified DTE service: cont. in X.32, impl. def. in X.32
Identification: cont. in X.32, impl. def. in X.32
Interface characteristics: cont. in X.32, impl. def. in X.32
International Numbering Plan: cont. in X.32, impl. def. in X.121
Link access procedure: cont. in X.32, impl. def. in X.32
Link level address assignment: cont. in X.32, impl. def. in X.32
Local Charging Prevention: cont. in X.32, impl. def. in X.25
Logical channel assignment: cont. in X.32, impl. def. in X.25

Modem characteristics: cont. in X.32, impl. def. in V-Rec.
Modem selection: cont. in X.32, impl. def. in X.32
Multilink: cont. in X.32, impl. def. in X.75

Nonidentified DTE service: cont. in X.32, impl. def. in X.32
NUI override permission: cont. in X.32, impl. def. in X.32

On-line facility registration: cont. in X.32, impl. def. in X.32
Optional user facility: cont. in X.32, expl. def. in X.15

Permanent virtual circuit: cont. in X.32, impl. def. in X.25

Questioning party: cont. in X.32, impl. def. in X.32

Registered PSN number: cont. in X.32, impl. def. in X.32
Registration procedure: cont. in X.32, impl. def. in X.25
RSA public key algorithm: cont. in X.32, impl. def. in X.32

Secure dial-back: cont. in X.32, impl. def. in X.32
Security grade: cont. in X.32, impl. def. in X.32

Temporary location: cont. in X.32, impl. def. in X.32
Test loops: cont. in X.32, impl. def. in X.150, impl. def. in V.54
Timer: cont. in X.32, impl. def. in X.32

User class of service: cont. in X.32, expl. def. in X.15

Virtual call: cont. in X.32, impl. def. in X.25

CCITT	International Telegraph and Telephone Consultative Committee
CUDF	Call or Clear User Data Field
CUG	Closed User Group
DCE	Data Circuit-Terminating Equipment
DISC	Disconnect
DM	Disconnected Mode
DSP	Domain Specific Portion
DTE	Data Terminal Equipment
FCS	Frame Check Sequence
FRMR	Frame Reject
GFID	General Format Identifier
GW-DTE	ateway-DTE
HDLC	High Level Data Link Control
IDI	Initial Domain Identifier
ISO	International Organization for Standardization
LAP	Link Access Procedure
LAPB	Link Access Procedure Balanced,
LC	Logical Channel
MLP	Multilink Procedure
NCP	Network Control Program
NSAP	Network Service Access Point
NSF	X.25 SNA Network Supervisory Function
PAD	Packet Assembly/Disassembly
PPSDN	Public Packet-Switched Data Network
PRPQ	Programming Request for Price Quotation
PSDN	Packet-Switched Data Network
PS	Packet Size
PVC	Permanent Virtual Circuit
QOS	Quality of Service
REJ	Reject
RNR	Receive Not Ready
RPOA	Recognized Private Organization Agency
RR	Receive Ready
SABM	Set Asynchronous Balanced Mode
SLP	Single Link Procedure
SNA	System Network Architecture
SVC	Switched Virtual Circuit
SYSGEN	ystem Generation
TC	Throughput Class
UA	Unnumbered Acknowledgment
VC	(1) Virtual Circuit, (2) Virtual Call
WS	Window Size
XI	X.25 SNA Interconnection
372x	IBM 3725/3720 Communication Controller

Definition of terms

This glossary contains definitions reprinted from:

(1) The American National Dictionary for Information Processing, copyright 1977 by the Computer and Business Equipment Manufacturers Association, copies of which may be purchased from the American National Standards Institute at 1430 Broadway, New York, New York 10018. These definitions are identified by an asterisk (*).

(2) The ISO Vocabulary of Data Processing, developed by the International Standards Organization, Technical Committee 97, Subcommittee 1. Definitions from published sections of this vocabulary are identified by the symbol (ISO) preceding the definition. Definitions from draft proposals and working papers under development by the ISO/TC97 vocabulary subcommittee are identified by the symbol (TC97), indicating that final agreement has not yet been reached among its participating members.

(3) The CCITT Sixth Plenary Assembly Orange Book, Terms and Definitions, published by the International Telecommunication Union, Geneva, 1978, and subsequent extensions. These are identified by the symbol (CCITT/ITU) preceding the definition.

barring: See calls barred.

byte: A sequence of eight adjacent binary digits that are operated upon as a unit and that constitute the smallest addressable unit in the system.

call: (CCITT/ITU) A transmission for the purpose of identifying the transmitting station for which the transmission is intended.

call accepted packet: A call supervision packet that a called DTE transmits to indicate to the DCE that it accepts the incoming call.

call collision: A condition that occurs when a DTE and a DCE simultaneously transmit a call request packet and an incoming call packet over the same logical channel. See also clear collision, reset collision.

call connected packet: A call supervision packet that a DCE transmits to indicate to a calling DTE that the connection for the call has been completely established.

call redirection: (CCITT/ITU) An optional user facility agreed for a period of time. This user facility, if subscribed to, redirects incoming calls destined to a DTE when (1) the DTE is out of order, or (2) the DTE is busy.

call redirection notification: (CCITT/ITU) A user facility used by the DCE in the incoming call packet to inform the alternate DTE that the call has been redirected, why the call was redirected, and the address of the originally called DTE.

call request packet: A call supervision packet that a DTE transmits to ask that a connection for a call be established throughout the network.

call supervision packet: A packet used to establish or clear a call at the interface between the DTE and the DCE.

call transfer: An XI-specific facility that permits a DTE (DTE A) communicating through an SVC with another DTE (DTE B) to locally clear the call with DTE B and to redirect that call to a third DTE (DTE C) in such a way that the only effect on DTE B is the necessity for a reset procedure to resynchronize packet level states.

called line address modified notification: (CCITT/ITU) 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.

calling: (TC97) The process of transmitting selection signals in order to establish a connection between data stations.

calls barred: (CCITT/ITU) A facility that permits a DTE to make outgoing or to receive incoming calls only (but not both).

cause code: The code used in the cause field of clear, reset, and restart request packets to indicate the reason for the request.

clear collision: A condition that occurs when a DTE and a DCE simultaneously transmit a clear request packet and a clear indication packet over tha same logical channel. See also call collision, reset collision.

clear confirmation packet: See DCE clear confirmation packet.

clear indication packet: A call supervision packet that a DCE transmits to inform a DTE that a call has been cleared.

clear request packet: A call supervision packet that a DTE transmits to ask that a call be cleared.

closed user group (CUG): (TC97) In a group of users, a subgroup that is assigned a facility that enables a member of one subgroup to communicate only with other members of the subgroup.

Note: A DTE may belong to more than one closed user group.

communication controller: A type of communication control unit whose operations are controlled by one or more programs stored and executed in the unit, for example the IBM 3725 Communication Controller.

communication controller node: A communication controller that contains a network control program.

D bit: Delivery confirmation bit, used in a packet header to request acknowledgement from its destination upon receipt.

data circuit-terminating equipment (DCE): (TC97) The equipment installed at the user's premises that provides all the functions required to establish, maintain, and terminate a connection, and the signal conversion and coding between the data terminal equipment (DTE) and the line.

Note: The DCE may be separate equipment or an integral part of other equipment.

data packet: (CCITT/ITU) A packet used for the transmission of user data on a virtual circuit at the DTE/DCE interface.

data terminal equipment (DTE): (TC97) That part of a data station that serves as a data source, data sink, or both, and provides for the data communication control function according to protocols.

DCE clear confirmation packet: A call supervision packet that a DCE transmits to confirm that a call has been cleared.

dedicated logical channel: The restriction of a logical channel for use on virtual circuits established in a particular way (by an incoming call, outgoing call, or call in either direction, or to a permanent virtual circuit).

default external addressing: Routing through a default gateway DTE when a called DTE address commences with neither a RAP nor a XAP.

default packet size: The packet size used in the absence of flow control parameter negotiation.

default packet window size: The packet window size used in the absence of flow control parameter negotiation.

default throughput class: The throughput class used in the absence of throughput class negotiation.

default transit delay: The transit delay used in the absence of transit delay selection and indication facility.

diagnostic code: A code used in diagnosic packets and in clear, reset, and restart indication packets to indicate errors, failures, or inherent incompatibilities of a DTE with the network or with another DTE.

diagnostic packet: A packet used to provide diagnostic direct call information from a DCE to a DTE.

direct call: An XI specific facility which consists in assigning to one or more than one logical channel of a DTE/DCE interface a complementary subscription parameter allowing the DTE to initiate an SVC set-up procedure on selected logical channels with parameters defined at subscription time (mainly the address of the called DTE).

discarded packet: A packet that is intentionally destroyed.

DTE address: (1) Home DTE address. (2) DTE number within an XI node.

DTE clear confirmation packet: A call supervision packet that a DTE transmits to confirm that a call has been cleared.

DTE generic address: See generic address.

DTE/DCE interface: (CCITT/ITU) The physical interface elements and the link access procedures between data terminal equipment (DTE) and data circuit-terminating equipment (DCE).

extended packet sequence numbering: Packet sequence numbering with modulo 128.

external address: This is used for DTEs attached to an XI node via an external X.25 network and consists of a prefix identifying the external network followed by an address of up to 14 digits. Contrast with relative address.

flag (F) sequence: The unique sequence of eight bits (01111110) employed to delimit the opening and closing of a frame.

flow control: (NPP/GI) In SNA, the process of managing the rate at which data traffic passes between components of the network. The purpose of flow control is to optimize the rate of flow of message units with minimum congestion in the network; that is, to neither overflow the buffers at the receiver or at intermediate routing nodes, nor leave the receiver waiting for more message units.

flow control parameter negotiation: A packet-switched data network optional facility that allows a DTE to negotiate the packet size and window size for communication with another DTE.

frame: The link-level unit for transmitting commands, responses, or packets over the physical circuit between a DTE and an adjacent DCE. It is a sequence of contiguous bits bracketed by and including opening and closing flag sequences.

frame check sequence (FCS): The field immediately preceding the closing flag sequence of a frame, containing the bit sequence that provides for the detection of transmission errors by the receiver.

frame window size: The number of I frames a DTE or DCE can send across a link before waiting for authorization to send another I frame. The window is the main mechanism of pacing or flow control of frames.

gateway DTE (GW-DTE): The XI function that provides an interface between an XI network and an external X.25 network.

general format identifier (GFID): Bits 0 through 3 of the first byte of an X.25 packet, containing the Q-bit, the D-bit, and the modulo.

generic address: The lowest home DTE address for a DTE when sub-addressing is used.

group: See closed user group, logical channel group, GROUP.

home DTE address: A component of the relative address for a DTE attached locally to an XI node. It consists of the XI node number and the DTE number.

I frame: See information frame.

incoming: From DCE to DTE or from remote DXE to local DXE. Contrast with outgoing.

incoming call packet: A call supervision packet that a DCE transmits to inform a called DTE that another DTE has requested a call.

information (I) frame: A frame in I format, used for numbered information transfer. See also supervisory frame, unnumbered frame.

interrupt packet: A packet used to interrupt a virtual circuit at the interface between the DCE and the DTE.

leased line: Synonym for nonswitched line.

line: Any physical medium, such as a wire or microwave beam, that is used to transmit data.

link: (1) * The physical means of connecting one location to another for the purpose of transmitting and receiving data.

(2) In SNA, the interconnecting data circuit between two or more equipments operating in accordance with a link protocol; it does not include the data source and the data sink.

link access procedure: The link level elements used for data interchange between a DCE and a DTE operating in user classes of service 8 to 11, as specified in CCITT Recommendation X.1. a linkage editor.

link level: The level of a communication protocol that specifies how data transferred across a link is formatted, checked, and recovered. Contrast with packet level, physical level.

local: Attached to this node or within this node.

logical channel (LC): (CCITT/ITU) In packet mode operation, a means of two-way simultaneous transmission across a data link, comprising associated send and receive channels.

Note: (1) A number of logical channels may be derived from a data link by packet interleaving.

(2) Several logical channels may exist on the same data link.

logical channel group: A group of logical channels on a single link.

logical channel group number (LCGN): A number identifying a group of logical channels within a link.

logical channel identifier: The combination of a logical channel group number and a logical channel number (in that sequence).

logical channel number (LCN): (1) A number identifying an individual logical channel within a logical channel group. (2) In NSF operator commands, a number identifying a logical channel within a link, and equal to LCGN*256 + LCN.

M bit: More data bit, used in a packet header to indicate that more data follows that is logically connected with this packet.

modulo: The numerical base used for packet sequence numbering.

multichannel link (MCH): (CCITT/ITU) A means of enabling a data terminal equipment (DTE) to have several access channels to the data network over a single circuit. Three likely methods have been identified: packet interleaving, byte interleaving, and bit interleaving.

NCP node: In an SNA network, a communication controller with NCP installed.

Network Control Program (NCP): An IBM licensed program that provides communication controller support for the physical management of a network; it controls attached links and devices, routes data, and performs error recovery routines.

nonswitched line: A telecommunication line on which connections do not have to be established by dialing. Synonymous with leased line. Contrast with switched line.

non-XI node: In an XI network, a communication controller that does not have XI installed. It can act only as a transit node.

normal DTE: Any DTE other than a gateway DTE or NPSI DTE.

NPSI: See X.25 NCP Packet Switching Interface.

NPSI bridge: The XI function that interfaces between XI and NPSI in the same XI node.

NPSI DTE: A DTE within NPSI, defined by an individual pseudo-link with XI in the same XI node.

NPSI node: In an SNA network, a communication controller with NPSI installed.

octet: (ISO) A byte composed of eight binary elements.

one-way logical channel incoming: An optional user facility that restricts the logical channel use to virtual circuits established by incoming calls.

one-way logical channel outgoing: An optional user facility that restricts the logical channel use to virtual circuits established by outgoing calls.

optional user facilities: Facilities that a user of a packet-switched data network can request when establishing a virtual circuit. These include closed user group, reverse charging, and throughput class negotiation.

outgoing: From DTE to DCE or from local DXE to remote DXE. Contrast with incoming.

packet: (TC97) A sequence of binary digits including data and call control signals that is switched as a composite whole. The data, call control signals and possibly error control information, are in a specific format.

packet assembly/disassembly (PAD): (CCITT/ITU) A user facility that permits non-packet mode terminals to exchange data in the packet mode.

packet level: The packet format and control procedures for the exchange of packets containing control information and user data between the DTE and the DCE. Contrast with link level, physical level.

packet level protocol (PLP): A protocol that defines communication at the packet level.

packet sequencing: (TC97) A process of ensuring that packets are delivered to the receiving DTE in the same sequence as they were transmitted by the sending DTE.

packet size: The length (in bytes) of a packet.

packet-switched data network (PSDN): A network that uses packet switching as a means of transmitting data.

packet switching: (TC97) The process of routing and transferring data by means of addressed packets so that a channel is occupied only during the transmission of a packet; upon completion of the transmission, the channel is made available for the transfer of other packets. Synonymous with packet mode operation. Contrast with circuit switching.

packet type: The type of packet sent between a DTE and DCE; for example, a call request, clear indication, DTE data, or diagnostic packet.

packet window size: The number of data packets a DTE or DCE can send across a logical channel before waiting for authorization to send another data packet. The window is the main mechanism of pacing or flow control of packets.

permanent virtual circuit (PVC): A virtual circuit that has a logical channel permanently assigned to it at each DTE. The usual call establishment protocol is therefore not required.

physical circuit: (CCITT/ITU) A circuit created with hardware rather than by multiplexing. Contrast with virtual circuit.

physical level: The mechanical, electrical, functional and procedural media used to activate, maintain and deactivate the physical link between the DTE and the DCE. Contrast with link level, packet level.

piggybacking: The carrying of flow control information in a data packet.

primary end: The end of a PVC that controls activation/deactivation of the PVC and at which statistics and accounting information are collected. Contrast with secondary end.

public packet-switched data network (PPSDN): A packet-switched data network operated for public subscribers.

public switched telephone network (PSTN): A circuit-switched voice network operated for public subscribers.

Q bit: Qualified data bit, used in a packet header to distinguish the qualified data from other data.

Recommendation X.25 (Geneva 1976, 1980; Torremolinos 1984): A CCITT recommendation for the interface between data terminal equipment and packet-switched data networks. See also packet switching.

relative address: This is used for DTEs attached directly to an XI node and consists of a prefix followed by an XI node number and a DTE number. See relative address prefix, home DTE address. Contrast with external address.

relative address prefix: The initial digit in the relative address of a DTE that identifies the network (XI, PSDN) to which the DTE is attached.

remote: Attached to another node or within the other node.

reset collision: A condition that occurs when a DTE and a DCE simultaneously transmit a reset request packet and a reset indication packet over the same logical channel. See also call collision, clear collision.

reset packet: A packet used to reset a virtual circuit at the interface between the DCE and the DTE.

restart packet: A packet used to restart a virtual circuit at the interface between the DCE and the DTE.

reverse charging: An optional facility of a packet-switched data network that enables a DTE to request that the cost of a session it initiates be charged to the DTE that is called. See also optional user facilities.

reverse charging acceptance: A facility that enables a DTE to receive incoming packets that request reverse charging.

RNR packet: A packet used by a DTE or by a DCE to indicate a temporary inability to accept additional packets for a given virtual call or permanent virtual circuit.

RR packet: A packet used by a DTE or by a DCE to indicate that it is ready to receive data packets within the window.

S frame: See supervisory frame

secondary end: The opposite end of a PVC from the primary end. Contrast with primary end.

segment: The measurement unit used for charging for the volume of information transmitted in a packet-switched service; its length is 64 octets.

sequence number: A number assigned to a particular frame or packet to control the transmission flow and receipt of data.

sub-address: A field within a DTE address that distinguishes different addresses within the DTE, used for example when the DTE is a concentrator or multiplexer.

supervisory (S) frame: A frame in supervisory format, used to transfer supervisory control functions. Contrast with information frame, unnumbered frame.

switched line: A telecommunication line in which the connection is established by dialing. Contrast with nonswitched line.

switched network access facility (SNAF): In XI, an optional facility that allows a user to attach an X.25 DTE to an XI node via a switched line of a public switched telephone network.

switched network backup (SNBU): In XI an optional facility that allows a user to specify for DTE links a switched line to be used as an alternative path if the primary line becomes unavailable or unusable.

switched virtual circuit (SVC): A virtual circuit that is established by one DTE making a call request to the network. It is released when a clear request is accepted.

system generation (SYSGEN): * (ISO) The process of selecting optional parts of an operating system and of creating a particular operating system tailored to the requirements of a data processing installation.

Systems Network Architecture (SNA): The description of the logical structure, formats, protocols, and operational sequences for transmitting information units through and controlling the configuration and operation of networks.

Note: The layered structure of SNA allows the ultimate origins and destinations of information (that is, the end users) to be independent of, and unaffected by, the specific SNA network services and facilities used for information exchange.

throughput class: A class of service that determines the speed at which packets travel through a packet-switched data network.

throughput class negotiation: A packet-switched data network optional facility that allows a DTE to negotiate the speed at which its packets travel through the packet-switched data network.

time-out: (CCITT/ITU) A parameter related to an enforced event designed to occur at the conclusion of a predetermined elapsed time.

transit delay: The time taken by packets to transit a specified part of a network, such as between two nodes.

transit node: In an XI network, a communication controller through which packets pass without any processing by XI. Both XI nodes and non-XI nodes can be transit nodes.

two-way logical channel: A logical channel that can be used in virtual circuits that are established by either an incoming call or an outgoing call.

U frame: See unnumbered frame

unnumbered (U) frame: A frame in unnumbered format, used to transfer unnumbered control functions. Contrast with information frame, supervisory frame.

virtual call: (CCITT/ITU) A user facility in which a call set-up procedure and a call clearing procedure will determine a period of communication between two DTEs in which user's data will be transferred in the network in the packet mode of operation. All the user's data is delivered from the network in the same order in which it is received by the network. Synonymous with switched virtual circuit.

virtual circuit (VC): A logical connection established between two DTEs. It can be permanent, that is, defined when you subscribe to your network port, or it can be dynamically established when creating a switched virtual circuit. Contrast with physical circuit.

Virtual Telecommunications Access Method (VTAM): (NPP/GI) An IBM licensed program that controls communication and the flow of data in an SNA network. It provides single domain, multiple domain, and interconnected network capability.

VTAM: Virtual Telecommunications Access Method (IBM licensed program). Its full name is Advanced Communications Function for the Virtual Telecommunications Access Method.

window size: See frame window size, packet window size.

wraparound: The continuation of an operation from the maximum addressable location in storage to the first addressable location.

XI gateway: An XI node that is used to interface to an external X.25 network.

XI identifier: An XI network address or local address.

XI network: A set of XI nodes connected by SNA links.

XI node: A communication controller with XI installed.

X.25: See Recommendation X.25.

X.25 NCP Packet Switching Interface (NPSI): An IBM licensed program that allows SNA users to communicate over packet-switched data networks that have interfaces complying with Recommendation X.25 (Geneva 1980) of the International Telegraph and Telephone Consultative Committee (CCITT). It allows SNA programs to communicate with SNA equipment or with non-SNA equipment over such networks.

X.25 network: A packet-switched data network that provides a DTE/DCE interface conforming to the X.25 recommendation.

X.25 SNA Interconnection (XI): An IBM Licensed Program that runs in a communication controller to provide packet-level handling for X.25 traffic.

X.25 SNA Network Supervisory Function (NSF): An IBM Licensed Program that runs in an SNA host processor to provide operator and report-gathering functions for an XI network.

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X.25 SNA Interconnection
Program Numbers 5685-005 and 5685-035
DTE/DCE Interface Description
Order No. GH19-6576-0

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