ECMA
EUROPEAN COMPUTER MANUFACTURERS ASSOCIATION

STANDARD ECMA-112

X.25 (1980) SUBNETWORK-DEPENDENT CONVERGENCE PROTOCOL

December 1985

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European Computer Manufacturers Association
114 Rue du Rhône – 1204 Geneva (Switzerland)

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BRIEF HISTORY

In 1981 ECMA started work on a standard for the Interface Characteristics for a DTE to Operate with the European Rec. X.25 Networks. The object of this work was to identify a common sub-set of facilities, chosen from those commonly implemented, that would permit standardization of a DTE design that would satisfy the majority of users requirements to cover the period at least to 1985.

During this work it became clear to ECMA that alignment with the OSI Network Service would be essential. However, ECMA completed its work whilst the Network Service definition was still evolving and the decision was taken in 1983 to publish the work as a Technical Report (TR/16) pending the stabilization of the Network Service in ISO.

In 1984 close alignment was reached between X.25 (1984) and the OSI Network Service, with ISO also defining convergence protocols to permit X.25 (1980) implementations to provide the OSI Network Service.

ECMA has now converted TR/16 to a standard by the addition of a sub-set of the OSI Convergence Protocol (DP 8878) that will enable X.25 (1980) network implementations across Europe to support the OSI Network Service.

Adopted as an ECMA Standard at the General Assembly of Dec. 12, 1985.

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1. SCOPE AND FIELD OF APPLICATION

CCITT Recommendation X.25 (1984) and ISO DIS 8208 define facilities that will adequately support the ISO Connection-Oriented Network Service over X.25 subnetworks. However, until all public and private packet-switched X.25 networks, and existing X.25 DTEs, conform to X.25 (1984), there is a need for a method of providing the Connection-Oriented Network Service over the X.25 (1980) subnetwork access protocol.

This ECMA Standard defines a subnetwork dependent convergence protocol (as defined in ISO 8648) to offer the ISO Connection-Oriented Network Service over an X.25 subnetwork service. The convergence protocol is applicable in the following cases :

- When the X.25 service does not support the full Network Service (that is when the X.25 service conforms to the 1980 recommendation).
- When the resulting service for a concatenation of X.25 subnetworks only conforms to the 1980 recommendations, even when one or more of the subnetworks conform to later X.25 recommendations.
- When the X.25 subnetwork conforms to a CCITT recommendation later than 1980, but when the calling or called DTE only implements the 1980 recommendations.

The Standard specifies a minimal set of procedures that will support the ISO Connection-Oriented Network Service, principally by the use of protocol parameters conveyed within X.25 User Data Fields. The parameter encodings have been aligned to the facility codes of X.25 (1984) as defined in ISO 8208.

2. REFERENCES

ECMA TR/16	:Interface characteristics for a DTE to operate with European Rec X.25 Networks.
ISO 7498	:Information Processing Systems - Open Systems Interconnection - Basic Reference Model.
ISO 8348	:Information Processing Systems - Open Systems Interconnection - Connection Oriented Network Service Definition.
ISO 8208	:Data Communication - X.25 Packet Level Protocol for Data Terminal Equipment
ISO 8648	:Information Processing Systems - Data Communications Internal Organization of the Network Layer.
ISO 8348/DAD2	:Addendum to the Network Service Definition Covering Network Layer Addressing.
ISO 8878	:Use of X.25 to Provide the OSI Connection-Oriented Network Service.

3. DEFINITIONS

3.1 Reference Model Definitions

The following concepts, developed and defined in the OSI Reference Model (ISO 7498), are used in this document :

a. Network connection;
b. Network Layer;
c. Network Service;
d. Network Service access point ;
e. Network Service access point address; and
f. Subnetwork.

3.2 Service Conventions Definitions

The following terms, as they apply to the Network Layer and as defined in the Service Conventions Standard (ISO 8509), are used in this document :

a. Network Service User;
b. Network Service Provider;
c. Primitive;
d. Request;
e. Indication;
f. Response; and
g. Confirm.

3.3 Network Service Definitions

The following terms, as defined in the Network Service (ISO 8348), are used in this document :

a. Calling Network Service user; and
b. Called Network Service user.

3.4 X.25 Definitions

The following concepts, as developed in the X.25 Packet Level Protocol for DTEs (ISO 8208) and in CCITT Recommendation X.25, are used in this document :

a. Virtual circuit
b. Virtual Call;
c. Logical channel;
d. Packet-switched data networks (subnetworks);
e. Packet Level;
f. Data Terminal Equipment;
g. Data Circuit-terminating Equipment.

4. ACRONYMS

4.1 Network Service Acronyms

CONS	Connection-Oriented Network Service
N	Network
NC	Network Connection
NL	Network Layer
NS	Network Service
NSAP	Network Service Access Point
OSI	Open Systems Interconnection
QOS	Quality of Service
NPDU	Network Protocol Data Unit
NSDU	Network Service Data Unit

4.2 X.25 Acronyms

DCE	Data Circuit-terminating Equipment
DTE	Data Terminal Equipment
GFI	General Format Identifier
LC	Logical Channel
PLP	Packet Level Protocol
P(R)	Packet receive sequence number
VC	Virtual Call
Q	Qualifier Bit
D	Delivery Confirmation Bit
M	More Data Bit
P(S)	Packet Send Sequence Number

4.3 Other Acronyms

DSP	Domain Specific Part
PT	Parameter Type
LI	Length Indicator
PV	Parameter Value
ID	Identifier
DSP	Domain specific part of a network address (see DP 8348/DAD2).
N-CR	Data packet(s) which contain the Network Service Connect Request (Connect Indication) parameters.
N-CC	Data packet(s) which contain the Network Service Connect Confirm (Connect Response) parameters.
N-DR	Data packet(s) which contain the Network Service Disconnect Request (Disconnect Indication) parameters.

5. SERVICE PROVIDED BY THE NETWORK LAYER

The X.25 (1980) Network Convergence Protocol provides the mechanism for entities in the Network Layer to interact and provide the Network Service defined in ISO 8348.

5.1 Mapping of the Connection-Oriented Network Service onto X.25 (1980)

5.1.1 Connection Establishment

The table below shows the relationship between the primitives/parameters used during the Connection Establishment Phase and the packets/fields associated with the X.25 Call Setup Procedures.

CONS	X.25
PRIMITIVES:	PACKETS:
N-CONNECT request	Call Request & N-CR
N-CONNECT indication	Incoming Call & N-CR
N-CONNECT response	Call Accepted & N-CC
N-CONNECT confirm	Call Connected & N-CC
PARAMETERS:	FIELDS:
Called Address	Called DTE Address Field Called Address Extension
Calling Address	Calling DTE Addr. Field Calling Addr. Extension
Responding Address	Called Addr. Extension
QOS Parameter Set	Min. Throughput Class Transit Delay
NS-User Data	NS-User Data

5.1.2 Connection Release

The table below shows the relationship between the primitives/parameters used during the Connection Release Phase and the packets/fields associated with the Call Clearing Procedures.

CONS	X.25
PRIMITIVES:	PACKETS:
N-DISCONNECT request	Clear Request & N-DR
N-DISCONNECT indication	Clear Indication & N-DR Restart Indication (Note 1) Clear Request (Note 2)
PARAMETERS:	FIELDS:
Originator and Reason	Disconnect Originator (Note 3) Disconnect Reason (Note 3)
Responding Address	Called Address Extension
NS-User Data	NS-User Data

Note 1 :

Receipt of a Restart Indication packet should be treated as receipt of a Clear Indication packet for every logical channel and then mapped to an N-DISCONNECT indication primitive for every active NC associated with the Packet Level Protocol being restarted. The Restarting Cause Code and Diagnostic Code Fields are then treated in the same manner as the Clearing Cause Code and Diagnostic Code Fields (see Appendix A).

Note 2 :

If the X.25 Packet Level Protocol detects an error in its operation for which its action is to clear the virtual call (e.g. a format error in an Incoming Call packet of timeout condition), then it transmits a Clear Request packet. If the virtual circuit is associated with a network connection then it also signals an N-DISCONNECT indication primitive to the NS user.

Note 3 :

The combination of Cause Code and Diagnostic Code Fields is mapped to/from the combination of Originator and Reason parameters (see Appendix A).

5.1.3 Data Transfer

The table below shows the relationships between the primitives/parameters used for the Data Transfer Service and the packets/fields associated with the Data Transfer

CONS	X.25
PRIMITIVES:	PACKETS:
N-DATA request N-DATA indication	Data Data
PARAMETERS:	FIELDS:
NS-User Data	User Data, M-bit

5.1.4 Reset

The table below shows the relationships between the primitives/parameters used for the Reset Service and the packets/fields associated with the Reset Procedures.

CONS	X.25
PRIMITIVES:	PACKETS:
N-RESET request N-RESET indication	Reset Request Reset Indication Reset Request (Note 4)
N-RESET response N-RESET confirm	Reset Confirmation Reset Confirmation
PARAMETERS:	FIELDS:
Originator and Reason	Cause Code and Diagnostic Code Fields (Note 5)

Note 4 :

If the X.25 Packet Level Protocol detects an error in its operation for which its action is to reset the virtual call(e.g. a sequence error or a timeout condition) then it transmits a Reset Request packet and signals an N-RESET indication primitive to the NS user.

Note 5 :

The combination of Cause Code and Diagnostic Code Fields is mapped to/from the combination of Originator and Reason parameters.

6. REQUIRED FEATURES OF THE UNDERLYING X.25 SUBNETWORK

The X.25(1980) Network Convergence Protocol defined here depends on the availability of all the following X.25 features. Bracketed references are to CCITT Recommendation X.25(1980).

a. Procedures for virtual call service (4.1).

b. Procedures for data transfer (4.3), except:

   1. User data field length need only be the standard length. Note the standard maximum user data field length is 128 octets (4.3.2).

   2. Delivery confirmation bit is not required (4.3.3).

   3. The interrupt procedure is not required (4.3.7).

c. Procedures for flow control (4.4).

d. Call setup and clearing packets (6.2).

e. DTE and DCE data packets (8.2).

f. Flow control packets and reset packets (6.5).

g. Support of the diagnostic code field in the Clear, Reset and Restart packets (6.2.3.2, 6.5.3.2, 6.6.1.2). Diagnostic Codes may lie in the range 0 to 255 (Annex E and PTT variants). The codes should be handled transparently by the X.25 subnetwork.

h. DCE time-outs (Annex D.1).

i. DTE time-limits (Annex D.2).

The following X.25(1980) protocol elements shall be used in ways specified by the subnetwork administration :

j. Procedures for restart (3.3).

k Restart packets (6.6).

l. Range of logical channels (Annex A).

m. Actions taken by DCE (Annex C).

7. REQUIRED FEATURES OF THE X.25 DTE

The X.25(1980) Network Convergence Protocol defined here depends on the DTE supporting, as a minimum, all of the features listed in section 6. ECMA TR/16 specifies the interface characteristics of a DTE to operate with the common facilities of various national implementations of CCITT Recommendation X.25 (1980) packet-switched networks in Europe. Utilizing the information in TR/16 a number of specific DTE requirements are listed :

a. The DTE shall be able to handle the packets types listed in the remainder of this section in accordance with Recommendation X.25 unless otherwise stated. All packets shall contain an integral number of octets.

b. Call set-up and clearing packets :

DCE to DTE	DTE to DCE
Incoming Call	Call Request
Call Connected	Call Accepted
Clear Indication	Clear Request
Clear Confirmation	Clear Confirmation

Note 6:

The X.25(1980) Network Convergence Protocol defined here shall set bits 8 and 7 of the first octet of the Call User Data Field to ONE and ZERO respectively (see Section 11).

c. Call set-up and clearing - related timers :

X.25 Ref.	Started when	DTE action
T11	DCE issues an Incoming Call	Accept or reject within 180 s
T13	DCE issues a Clear Indication	Respond within 60 s
T21	DTE issues a Call Request	Wait for a minimum of 200 s for DCE Call connected or DCE Clear Indication. When timer expires transmit Clear Request.
T23	DTE issues a Clear Request	Wait for a minimum of 180 s for DCE Clear Confirmation or Clear Indication. When timer expires repeat the Clear Request. If second Clear Request is unsuccessful, report logical channel out-of-order to higher level (Note 7)

Note 7 :

Note some DTEs may perform this action n times before informing the higher level. The value of n may be greater than or equal to zero.

d. Data transfer and flow control packets :

DCE to DTE	DTE to DCE
DCE Data	DTE Data
RR (modulo 8)	RR (modulo 8)
RNR (modulo 8)	RNR (modulo 8)

Data packets sent by the DTE shall be numbered consecutively modulo 8, without any gap. Each P (S) must be within the current window, as defined in Recommendation X.25 (4.4.1.2).

Data packets received in correct sequence shall be acknowledged by the DTE using the P (R) field of data, RR or RNR packets.

Detection of an out-of-sequence packet or incorrect P (R) shall be interpreted as a protocol error and shall cause the DTE to initiate a Reset or Clear. Use Reset is on ISO-conforming procedure.

Note 8 :

There is no mechanism in Recommendation X.25 to ensure that data packets are acknowledged by the DCE within a reasonable time (i.e. rotation of the window). DTEs may want to guard against a protracted delivery delay of a data packet. One method of detecting delayed acknowledgment would be to implement the timer T25 as described in ISO 8208. If the data packet is not acknowledged within the time limit set, the virtual circuit should be reset before retransmission is attempted. (T25 is not part of the CCITT X.25 (1980) Recommendation).

e. Reset and Restart Packets :

DCE to DTE	DTE to DCE
Reset Indication	Reset Request
Reset Confirmation	Reset Confirmation
Restart Indication	Restart Request
Restart Confirmation	Restart Confirmation

f. Reset and Restart related timers :

X.25 Ref	Started when	DTE action
T10	DCE issues a Restart Indication	Respond within 60 s.
T12	DCE issues a Reset Indication	Respond within 60 s.
T20	DTE issues a Restart Request	Wait for a minimum of 180 s for DCE Restart Confirmation or Restart Indication. When timer expires, repeat Restart Request. If the second Restart Request is unsuccessful, report failure to a higher level.(Note 7)
T22	DTE issues a Reset Request	Wait for a minimum of 180 s for DCE Reset Confirmation or Reset Indication. If timer expires repeat the Reset Request or transmit a Clear Request. (Note 7)

g. Delivery Confirmation bit (D bit):

The DTE shall set the Delivery Confirmation bit to zero selecting local P(R) significance.

h. More Data Mark (M bit) :

The M bit must be used to ensure that NS parameters and NSDUs are sent and received as Complete Packet Sequences. A Complete Packet Sequence shall consists of :

i) zero or more full data packets with the M bit set to ONE, followed by,

ii) one data packet (empty, nonfull or full) with the M bit set to ZERO (Note 9).

The receiving DTE shall be prepared to receive such a sequence (Note 10).

Note 9 :

Some networks may reject or discard empty data packets.

Note 10 :

M bits may be added or removed by the network if the receiving DTE maximum data packet length is shorter than the sending DTE.

i. Qualifier bit (Q bit) :

The X.25 (1980) Network Convergence Protocol defined here utilizes the Q bit feature to indicate the conveyance of network service connection or disconnection parameters. Otherwise the Q bit shall normally be set to ZERO. The Q bit of every data packet belonging to the same Complete Packet Sequence shall have the same value.

j. Flow Control Parameters :

The DTE shall support the Recommendation X.25 defined default values for the window and packet size, namely :

window size = 2
packet size = 128 octets max.

The latter relates to the User Data Field in data packets.

k. User Facilities

The optional user facilities of Recommendation X.25 are not directly accessible across the Network Service boundary. Therefore the use of these facilities is outside the scope of this Standard.

l. Logical Channel Assignments :

Logical channel assignments will be agreed between the User and the Administration for a contractual period.

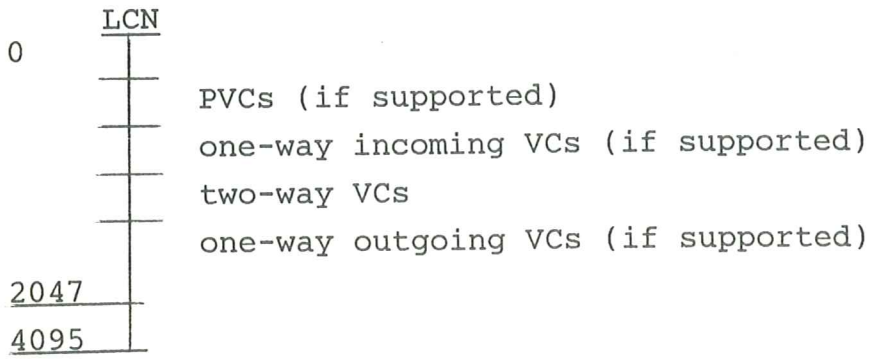
The DTE shall support the classes of logical channel shown below.

Although CCITT Rec. X.25 permits channel numbering up to 4095, many applications will use a much smaller number of channels.

To be compatible with European networks the DTE shall support channel numbering up to 2047, with Channel 0 reserved for restarts.

The DTE shall be able to cope with gaps in the numbering between the different classes of logical channel.

In order to minimize the risk of call collision when using the "two-way" logical channels, the DTE shall use the highest numbered logical channel in the "Ready" state when making a call.



m. The DTE shall accept and act upon Clear, Reset or Restart packets with any codings in the diagnostic field irrespective of whether these codes are recognized.

n. Called and Calling DTE Addresses :

It is essential that the DTE implementation imposes no restrictions on the number of digits or structure of these address fields.

8. FUNCTIONS PROVIDED BY THE PROTOCOL

8.1 Connection Establishment Phase

a. Connection Establishment

Initial establishment of the connection.

b. Addressing

Conveyance of the Calling and Called NSAP addresses.

c. QOS Negotiation

Negotiation of throughput and transit delay.

d. User Data

Carrying of User Data during the Connection Establishment Phase.

8.2 Connection Release Phase

a. Connection Release

Clearing down of the connection.

b. Addressing

For a connection rejection, conveyance of the Responding NSAP Address

c. Originator/Reason

Transfer of the originator and reason for failure.

d. User Data

Carrying user data during the connection release phase.

8.3 Data Transfer

a. Data Transfer

Uses X.25 Data packet for transferring data.

b. NSDU Segmentation

Provides ability to transfer NSDUs larger than the standard maximum user data field length of 128 octets by means of a Complete Packet Sequence.

c. NPDU Concatenation

Not required.

d. Error Detection

The error detection capability of X.25 networks is adequate to provide the Network Service. No additional mechanism is provided in the protocol.

e. Error Recovery

The error recovery capability of X.25 networks is adequate to provide the Network Service. No additional mechanism is provided in the protocol.

f. Sequence Preservation

Sequence preservation is inherent in X.25 subnetworks. No additional mechanism is provided in the protocol.

g. Receipt Confirmation

Not provided.

h. Expedited Data

Not provided.

8.4 Connection Control

a. Multiplexing

Multiple network connections are provided by the X.25 virtual circuits.

b. Splitting

Parallel use of X.25 calls to support one network connection is not a required service.

c. Flow Control

The X.25 flow control mechanisms are adequate to provide the Network Service. No additional mechanism is provided.

d. Reset

The X.25 reset mechanisms are adequate to provide the Network Service. No additional mechanism is provided.

e. Protocol Errors

If an unexpected packet, or a packet with an error in the convergence protocol parameters, is received, the protocol specifies the action to be taken.

9. PROTOCOL PROCEDURES

9.1 Connection Establishment Phase

This section describes the protocol support for the N-CONNECT primitives.

N-CONNECT request (indication) parameters are transferred by means of a Complete Packet Sequence of Packets with the Q-bit set to ONE. This is referred to as N-CR Complete Packet Sequence.

N-CONNECT response (confirm) parameters are transferred by means of a Complete Packet Sequence of Packets with the Q-bit set to ONE. This is referred to as a N-CC Complete Packet Sequence.

If a N-CR or N-CC Complete Packet Sequence consists of more than one packet then a packet is completed with Network Service parameters and the subsequent packet contains the next octet of the current parameter field in the first User Data octet position of this packet.

9.1.1 Procedures

When a N-CONNECT request is issued an X.25 Call Request packet shall be sent with the first octet of the Call User Data Field containing a Protocol Identifier (identifying the X.25 (1980) Convergence Protocol) and the second octet containing a Continuation Parameter (see section 10). The latter indicates that the Network Connection Request parameters will be conveyed in one or more X.25 Data packets, and it is required to ensure compatibility with ISO 8878.

The receiver of the corresponding X.25 Incoming Call packet shall accept the X.25 virtual call, respond with an X.25 Call Accept packet, and retain the Incoming Call for possible use in constructing the N-CONNECT indication (for example the calling NSAP).

When the virtual call is established, the N-CONNECT request parameters shall be conveyed in a N-CR Complete Packet Sequence enabling the Called DTE to generate an N-CONNECT indication.

No Data packets shall be transferred from the corresponding DTE while a N-CR Complete Packet Sequence is being transferred.

N-CONNECT response parameters are conveyed in a N-CC packet Complete Packet Sequence enabling the corresponding DTE to generate an N-CONNECT confirmation.

If there are no N-CONNECT response parameters, a N-CC Complete Packet Sequence containing only the convergence protocol message code (see section 10) shall be sent.

9.1.2 Addressing

In cases when a DTE address in an X.25 DTE Address field is sufficient to also convey the decimal representation of the corresponding NSAP address, no additional protocol mechanism need be used.

Otherwise, NSAP addresses are a local operational matter and any acceptable scheme from DP 8348/DAD2 may be used. The called and the calling address extension fields are used to convey the NSAP addresses. See section 10.4.6.

9.1.3 Service Negotiation

Receipt Confirmation is not supported.

9.1.4 QOS Negotiation

The X.25 (1980) Convergence Protocol optionally provides use of the Minimum Throughput Class Negotiation and the End-to-End Transit Delay Negotiation facilities.

9.1.4.1 Minimum Troughput Class Negotiation

If Minimum Throughput Class Negotiation is required the calling DTE indicates for each direction of data transmission a minimum acceptable value for the throughput class by means of the Minimum Throughput Class Negotiation Facility in the N-CR Complete Packet Sequence. These two values are conveyed transparently to the called DTE in the incoming N-CR Complete Packet Sequence. Gateways, private networks, and the called DTE may clear the call if resources necessary to support the minimum acceptable throughput classes are not available. The absence of this facility indicates that the calling DTE does not place a lower limit on the acceptable throughput classes.

The values conveyed by this facility in the N-CR Complete Packet Sequence are supplied by the N-CONNECT request primitive. Similarly the values received in the incoming N-CR Complete Packet Sequence are passed to the higher layer by means of the N-CONNECT indication primitive.

9.1.4.2 End-to-End Transit Delay Negotiation

If End-to-End Transit Delay Negotiation is required the calling DTE indicates cumulative transit delay of the X.25 Level 3 and lower level protocols in the DTE, including the affects of the access line transmission rate, by means of the End-to-End Transit Delay Negotiation Facility in the N-CR Complete Packet Sequence. The cumulative value is conveyed transparently by public data networks and is updated by gateways and the called DTE as the call set up is progressed.

In addition to the cumulative transit delay, the calling DTE may optionally indicate a desired (target) value for the end-to-end transit delay. If the target value is indicated, the calling DTE may optionally indicate a maximum acceptable value for the end-to-end transit delay. These values, when present, are supplied by the N-CONNECT request primitive and are conveyed transparently in the N-CR Complete Packet Sequence. The absence of these facilities indicates that the calling DTE did not provide a target value and/or upper limit on the transit delay.

Gateways, private networks, and the called DTE should clear the call if the cumulative transit delay exceeds the maximum acceptable transit delay, if specified. The maximum acceptable transit delay, when present, and the cumulative transit delay as computed by the Packet Level of the called DTE are passed to the higher level by means of the N-CONNECT indication.

The cumulative transit delay computed by the Packet Level of the called DTE is indicated in the N-CC Complete Packet Sequence which is conveyed transparently to the calling DTE, and then passed to the higher level by means of the N-CONNECT confirm primitive.

9.1.5 Connect User Data

N-CONNECT user data shall be carried in N-CR and N-CC Complete Packet Sequences.

9.2 Connection Release Phase

This section describes the protocol support for the N-DISCONNECT primitives.

N-DISCONNECT request (indication) parameters are transferred by means of a Complete Packet Sequence of packets with the Q-bit set to ONE. This is referred to as a N-DR Complete Packet Sequence.

If a N-DR Complete Packet Sequence consists of more than one packet then a packet is completed with Network Service parameters and the subsequent packet contains the next octet of the current parameter field in the first User Data octet position of this packet.

9.2.1 Procedures

When a N-DISCONNECT request is issued a N-DR Complete Packet Sequence shall be sent containing the appropriate service parameters. On receipt of the N-DR Complete Packet Sequence a N-DISCONNECT indication is issued and the receiving DTE shall transmit an X.25 Clear Request. To complete the disconnection, the DTE receiving the Clear Indication responds by sending a Clear Confirmation.

Any outstanding reset procedures shall be first completed before sending a N-DR Complete Packet Sequence.

Once the N-DR sequence is transmitted there shall be no more interaction with the user. In particular Data packets received will be discarded and no further Data packets will be transmitted.

A DTE on receiving the N-DR Complete Packet Sequence shall not send any further Data packets.

A Network Service Provider (i.e. the X.25 (1980) Packet level or the X.25 sub-network) connection release will not generate a N-DR Complete Packet Sequence. Originator and Reason Parameters will be derived from the clear/restart Cause and Diagnostic Code Fields. This situation is distinguishable from other forms of connection release (see section 9.2.2 below).

9.2.2 Disconnect Originator and Reason Parameters

Connection release Originator and Reason parameters will normally be carried in the N-DR Complete Packet Sequence. However a Network Provider connection release will not have an associated N-DR sequence and thus Originator and Reason parameters are based on the Cause and Diagnostic Codes Fields of the clear or restart packet.

For NS user originated disconnect request (indications), the values used are given in Appendix A, Table 1.

For DTE provider connection release Table 1 in Appendix A is also used.

For subnetwork connection release Table 2 in Appendix A provides interpretation.

9.2.3 Disconnect User Data

The N-DISCONNECT request User Data shall always be transferred in a N-DR Complete Packet Sequence.

9.3 Data Transfer Phase

This section describes the protocol support for the N-DATA primitive.

9.3.1 Procedures

NSDUs shall be sent as a X.25 Complete Packet Sequence with the Q bit set to ZERO.

The X.25 Convergence Protocol shall not perform NPDU concatenation.

The error detection and error recovery mechanisms of X.25 networks are adequate and no further Convergence Protocol mechanisms are needed.

An X.25 network is inherently sequence preserving. No additional mechanisms are provided.

Receipt Confirmation and Expedited Data are not supported.

9.4 Connection Control

This section includes a description of the protocol support for the N-RESET primitives.

9.4.1 Procedures

The X.25 reset mechanisms are adequate to support the Network Service reset function.

When a N-RESET request is to be actionned the following are discarded : all DTE Data packets, data acknowledgement counts or related information held for either direction of the connection. The Originator and Reason parameters of the reset request shall be transferred in the Reset Request packet in the Cause Code and Diagnostic Field.

For NS user originated reset requests, the values of the Cause Code and Diagnostic Field, with their interpretations, is given in Appendix A, Table 3.

For DTE entity initiated reset Table 3 in Appendix A is also used.

For subnetwork initiated reset Table 4 in Appendix A provides interpretation.

The action to be taken upon detection of errors in the X.25 protocol or packet formats is contained in the X.25 specification. If errors are detected in the convergence protocol parameters of a received packet, or any other error is detected for which there is no explicit event in the convergence protocol state/event table, the "Any Other Event" for that state shall be taken.

9.5 X.25 Facilities

Q bit	Set to ONE if the data packet carries information coded using the subnetwork dependent convergence protocol encoding. See 7(i).
M bit	The M bit is used if an NSDU is too large to be sent in one data packet, or if connect or disconnect parameters are too large to be sent in single N-CR, N-CC, or N-DR packets. See 7(h).
Restart	An X.25 restart will cause the disconnection of all network connections to which it applies.
Flow Control	The X.25 flow control mechanisms are used and do not require any enhancement.
Logical Channel	Each Network connection maps onto a single X.25 logical channel.
Diagnostic Code	This field is used to transfer Reason information.
X.25 Diagnostic	Not supported. It will cause the "any other Packet event" actions in the state/event table in Appendix B.

9.6 Network Relaying (Gateways)

For a network relay between two X.25 subnetworks, for network connections for which the X.25 (1980) Network Convergence Protocol is used on both sides of the relay, each received NPDU is normally passed on unaltered to the other subnetwork. However the NPDU may be modified in the following circumstances :

- The connected subnetworks have different permissible NPDU sizes requiring different concatenation or segmentation.
- On a Connect Request the received parameters, options and addresses have to be analized and new values derived (eg. for QOS) for the connect request to be passed on.
- The relay provider can itself generate a Disconnect or Reset message.

Any parameter types or values which are not known to this particular relay provider should be passed unaltered on the basis that they will be meaningful at another stage of the call.

9.7 Timers

9.7.1 Connect Response Timer

When the connection establishment procedure is initiated, the Connect Response Timer shall be started by the caller. The timer is normally terminated when the connection establishment is complete. If the timer expires, the connection shall be disconnected.

The use and action of the timer is shown in the state/event table in Appendix B.

The value for this timer is an implementation option.

9.7.2 Disconnect Response Timer

When either the disconnect procedure is initiated, the Disconnect Response Timer shall be started by the DTE initiating the disconnection. The timer is normally terminated when the disconnection is complete. If the timer expires, the connection shall be returned to an idle state.

The use and action of the timer is shown in the state/event table in Appendix B.

The value of this timer is an implementation option.

9.7.3 Timer for Reset Procedure

The X.25 Reset Request Response Timer (T22) is adequate to protect against loss of reset protocol messages, or non-response from the corresponding DTE.

10. PROTOCOL DESCRIPTION

10.1 State/Event Transitions

A state/event table for the operation of the X.25 (1980) Network Convergence Protocol is included in Appendix B. This is an integral part of the protocol description.

10.2 Encoding Principle

Network Service parameters are transferred in N-CR, N-CC and N-DR Complete Packet Sequences.

The structure of the network parameter encoding is as follows:

	8	7	6	5	4	3	2	1
	Message Code Type							
1	0	0	1	0	0	0	0	0
2	Message Code Value							
3	Parameter Type (PT)							
4	Parameter Value (PV)							
	Further parameter types and values							

Note 11 :

Bits within an octet are numbered 1 to 8 where 8 is the most significant and 1 is the least significant.

Note 12 :

Octets in a packet are consecutively numbered starting from 1 and are transmitted in this order.

Note 13 :

The least significant bit of an octet shall be transmitted first on the X.25 subnetwork.

The encoding of the message codes and parameter types is based on the encoding used for the X.25 facility field. This is, bits 8 and 7 of the parameter type (PT) indicate the length class of the associated parameter value field.

	8 7 6 5 4 3 2 1
1 octet parameter value field	0 0 x x x x x x
2 octet parameter value field	0 1 x x x x x x
3 octet parameter value field	1 0 x x x x x x
Variable length parameter value (PV) field	1 1 x x x x x x

For the variable length field, the first octet is a Length Indicator (LI) defining the length of the associated parameter value field.

Where there is an equivalent X.25 (1984) facility field, the same encoding is used for the parameter type. Otherwise, bit 6 is set to ONE, to ensure that the parameter type value does not conflict with any currently used CCITT facility parameters. Since the above encoding is based on the X.25 (1984) facility fields, the maximum length of the X.25 facilities and encoded parameters (excluding NS-User Data) shall not exceed 109 octets.

10.3 Parameter Type Encoding

8	7	6	5	4	3	2	1	Hex	
0	0	0	0	1	0	1	0	0A	Minimum throughput class
0	0	1	0	0	0	0	0	20	Message Code
0	0	1	0	1	0	0	1	29	Disconnect Originator
0	0	1	0	1	0	1	1	2B	Disconnect Reason
0	0	1	0	1	1	0	1	2D	Continuation
1	1	0	0	1	0	0	1	C9	Called Address Extension
1	1	0	0	1	0	1	0	CA	Transit Delay
1	1	0	0	1	0	1	1	CB	Calling Address Extension
1	1	1	0	0	1	0	0	E4	NS-User-Data

Note 15 :

The order in which the convergence protocol parameters are placed in the data field is unimportant.

10.4 Parameter Descriptions

10.4.1 Minimum Throughput Class

The one-octet parameter value field contains the minimum throughput class for both directions of data transmission. The minimum throughput class for the direction of data transmission from the called DTE is indicated in bits 8, 7, 6 and 5. The minimum throughput class for the direction of data transmission from the calling DTE is indicated in bits 4, 3, 2 and 1.

The four bits indicating each throughput class are binary coded and correspond to throughput classes as indicated below :

bit : 8	7	6	5	Throughput class
or				
bit : 4	3	2	1	(bits per second)
0	0	0	0	Reserved
0	0	0	1	Reserved
0	0	1	0	Reserved
0	0	1	1	75
0	1	0	0	150
0	1	0	1	300
0	1	1	0	600
0	1	1	1	1200
1	0	0	0	2400
1	0	0	1	4800
1	0	1	0	9600
1	0	1	1	19200

1	1	0	0	48000
1	1	0	1	Reserved
1	1	1	0	Reserved
1	1	1	1	Reserved

10.4.2 Message Code

Message codes are used to identify the type of convergence protocol message. Three message codes are defined to identify N-CR, N-CC and N-DR.
The message code appears at the start of a single packet or the first packet of a Complete Packet. The one- octet parameter contains the Message Code Value, as below :

8	7	6	5	4	3	2	1	Hex	
0	0	0	0	0	0	0	1	(01)	X.25 Data (N-CR)
0	0	0	0	0	0	1	0	(02)	X.25 Data (N-CC)
0	0	0	0	0	0	1	1	(03)	X.25 Data (N-DR)

10.4.3 Disconnect Originator

The encoding for Disconnect Originator, when it is carried as a parameter, shall have the values :

8	7	6	5	4	3	2	1	Hex	
0	0	0	0	0	0	0	1	(01)	NS User
0	0	0	0	0	0	1	0	(02)	NS Provider

10.4.4 Disconnect Reason

The encoding for Disconnect Reason, when it is carried as a parameter, shall have the same value as that of the equivalent X.25 Diagnostic Code, as given in Appendix A Table 1.

10.4.5 Continuation

This parameter denotes that Network Service parameters follow in a Complete Packet Sequence. The parameter is sent in the facility field of the X.25 Call Request packet (see section 11). For consistency with the X.25 encoding scheme, an octet with a zero value should follow this parameter.

10.4.6 Address Parameters

The Calling Address Extension parameter is used to convey the Calling NSAP Address. The Called Address Extension parameter is used to convey either the Called NSAP Address, when it is present in an X.25 Data (N-CR) packet, or the Responding NSAP Address, when it is present in the N-CC or N-DR packet types.

The various formats of NSAP addresses are described in DP 8348/DAD2.

If an NSAP address has the format X.121-DTE-DECIMAL, with an empty DSP, and if the DTE address it contains is equal to the corresponding DTE address for the subnetwork connection, the NSAP address is conveyed in the X.25 DTE address field, and there is no convergence protocol address parameter for that NSAP address.

If an NSAP address has the format X.121-DTE-DECIMAL, with a non-empty DSP, or the format X.121-DTE-BINARY, and if the DTE address it contains is equal to the corresponding DTE address for the subnetwork connection, the corresponding convergence protocol address parameter may be used, in which case it shall contain the encoding of the following digits, in order:

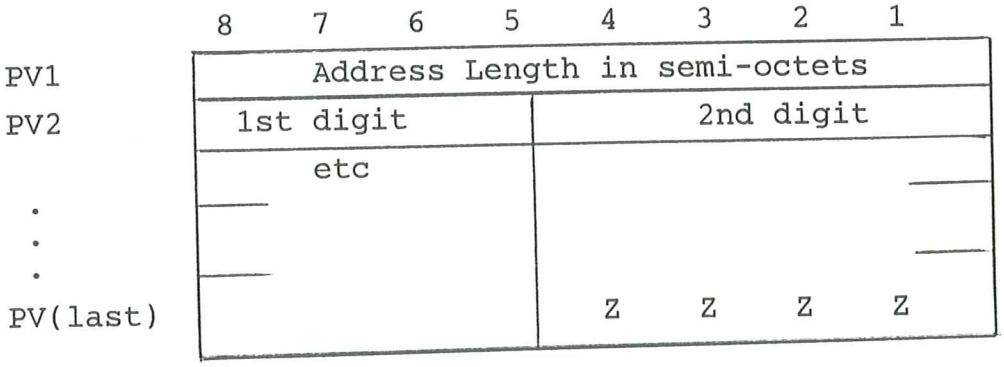
a. the digit 0;

b. the decimal representation defined in DP 8348/DAD2 of the NSAP format identifier;

c. the decimal representation defined in DP 8348/DAD2 of the DSP

If the NSAP address is not conveyed by either of the preceding methods, the corresponding convergence protocol address parameter shall be used, and shall contain the encoding of the decimal representation of the entire NSAP address.

When the convergence protocol address parameter is used to convey a digit string, the parameter value field shall be encoded as follows :



a. The value of PV1 shall not exceed 40 decimal.

b. Each digit of a digit string is coded in a semi-octet in binary coded decimal, where bit 5 or 1 is the low-order bit of the digit.

c. Starting from the high-order digit, the digit string is coded in octet PV2 and consecutive octets of the parameter value field with two digits per octet. In each octet the high order digit shall be coded in bits 8, 7, 6 and 5.

d. When the digit string consists of an odd number of digits then bits 4, 3, 2 and 1 of the last octet (marked "Z" above) shall be zeros, otherwise they shall be the binary coded decimal encoding of the least significant digit of the address.

10.4.7 Transit Delay

The octet following the parameter type field indicates the length in octets of the following parameter field and has the value 2, 4 or 6. The parameter field follows the length and indicates the transit delay values conveyed transparently over the X.25 subnetwork.

The first and second octets of the parameter field contain the cumulative transit delay. The third and fourth octets are optional and, when present, contain the desired (target) end-to-end transit delay. If the third and fourth octets are present, then the fifth and sixth octets are also optional.

When present, these octets contain the maximum-acceptable end-to-end transit delay. The absence of the optional octets in the N-CR packets indicates that any transit delay is acceptable for the network connection. Cumulative transit delay is the only parameter conveyed in the N-CC packet.

Transit delay is expressed in milliseconds and is binary-coded, with bit 8 of octet 1 being the high-order bit and bit 1 of octet 2 being the low-order bit.

If both the first and second octets of the parameter field each have the value 255, this indicates that the cumulative transit delay is unknown or exceeds 65534 milliseconds.

10.4.8 NS-User Data

NS-User Data is encoded as a string of octets.

11. PROTOCOL ENCODING IN X.25 PACKETS

11.1 Connection Establishment Packet

11.1.1 Call Request and Incoming Call

	8	7	6	5	4	3	2	1
1	General format identifier				Logical Channel Group			
	0	0	0	1				
2	Logical Channel Number							
	Packet type identifier							
3	0	0	0	0	1	0	1	1
4	Calling DTE addr length				Called DTE addr length			
	DTE Addresses							
					0	0	0	0
	0	0	Facility length					
	Facilities							
			Protocol ID (Note 15)					
	1	0	0	0	0	1	0	0
	"Network" Parameter (Note 16)							

Note 15 :

Bits 8 and 7 of the Call User Data Field are used for X.25 (1980) Network Convergence Protocol identification. This field has been allocated by ISO. This ECMA Convergence Protocol is a compatible subset of the ISO X.25 (1980) Network Convergence Protocol.

Note 16 :

The only, mandatory, parameter is :

Continuation PT=2D

For consistency, a zero filled octet should follow this parameter.

11.1.2 Call Accepted and Call Connected

	8	7	6	5	4	3	2	1
	General format identifier				Logical Channel Group			
1	0	0	0	1				
2	Logical Channel Number							
	Packet type identifier							
3	0	0	0	0	1	1	1	1

Note 17 :

This packet format is a minimum.

11.1.3 X.25 Data N-CR

	8	7	6	5	4	3	2	1
	General format identifier				Logical Channel Group			
1	1	0	0	1				
2	Logical Channel Number							
3	P(R)			M	P(S)			0
	Message Code Type (Note 18)							
4	0	0	1	0	0	0	0	0
	Message Code Value (Note 18)							
5	0	0	0	0	0	0	0	1
	"Network" Parameters (Note 19)							

Note 18 :

The Message Code parameters are present only in the first packet of the N-CR Complete Packet Sequence.

Note 19 :

Allowed parameters are :

Called Address Extension PT=C9 (+LI,PV)

Calling Address Extension PT=CB (+LI,PV)

QOS Parameters

- Minimum Throughput Class PT=0A (+PV)

- Transit Delay PT=CA (+LI,PV)

NS-User Data PT=E4 (+LI,PV)

Parameters may be in any order.

If there is a Complete Packet Sequence of packets, all but the last packet shall be full. If necessary parameters shall be fragmented to fill packets, with the first part completing one packet and the remainder occupying the start of the user data of the next packet of the sequence.

11.1.4 X.25 Data N-CC

	8	7	6	5	4	3	2	1
1	General format identifier				Logical Channel Group			
	1	0	0	1				
2	Logical Channel Number							
3	P(R)			M	P(S)			0
	Message Code Type (Note 20)							
4	0	0	1	0	0	0	0	0
	Message Code Value (Note 20)							
5	0	0	0	0	0	0	1	0
	"Network" Parameters (Note 21)							

Note 20 :

The Message Code parameters are present only in the first packet of the N-CC Complete Packet Sequence.

Note 21 :

Allowed parameters are :

Called Address Extension PT=C9 (+LI,PV)

QOS Parameters

- Minimum Throughput Class PT=0A (+PV)

- Transit Delay PT=CA, (+LI,PV)

NS-User-Data PT=E4 (+LI,PV)

Parameters may be in any order.

If there is a Complete Packet Sequence of packets, all but the last packet shall be full. If necessary parameters shall be fragmented to fill packets, with the first part completing one packet and the remainder occupying the start of the user data of the next packet of the sequence.

11.2 Connection Release Packets

11.2.1 X.25 Data N-DR

	8	7	6	5	4	3	2	1
1	General format identifier				Logical Channel Group			
	1	0	0	1				
2	Logical Channel Number							
3	P(R)			M	P(S)			0
	Message Code Type (Note 22)							
4	0	0	1	0	0	0	0	0
	Message Code Value (Note 22)							
5	0	0	0	0	0	0	1	1
	"Network" Parameters (Note 23)							

Note 22 :

The Message Code parameters are present only in the first packet of the N-DR Complete Packet Sequence.

Note 23 :

Allowed parameters are :

Called Address Extension	PT=C9 (+LI,PV)
Disconnect Originator	PT=29 (+PV)
Disconnect Reason	PT=2B (+PV)
NS-User Data	PT=E4 (+LI,PV)

Parameters may be in any order.

If there is a Complete Packet Sequence of packets, all but the last packet shall be full. If necessary parameters shall be fragmented to fill packets, with the first part completing one packet and the remainder occupying the start of the user data of the next packet of the sequence.

11.2.2 Clear Request and Clear Indication

	8	7	6	5	4	3	2	1
1	General format identifier				Logical Channel Group			
	0	0	0	1				
2	Logical Channel Number							
	Packet type identifier							
3	0	0	0	1	0	0	1	1
4	Clearing Cause							
5	Diagnostic Code							

11.2.3 Clear Confirmation

	8	7	6	5	4	3	2	1
1	General format identifier				Logical Channel Group			
	0	0	0	1				
2	Logical Channel Number							
	Packet type identifier							
3	0	0	0	1	0	1	1	1

11.3 Data

Normal Data (Q=0)

	8	7	6	5	4	3	2	1
1	General format identifier				Logical Channel Group			
	0	0	0	1				
2	Logical Channel Number							
3	P(R)			M	P(S)			0
	User Data							

11.4 Reset Request and Reset Indication

	8	7	6	5	4	3	2	1
1	General format identifier				Logical Channel Group			
	0	0	0	1				
2	Logical Channel Number							
	Packet type identifier							
3	0	0	0	1	1	0	1	1
4	Resetting Cause							
5	Diagnostic Code							

11.5 Reset Confirmation

	8	7	6	5	4	3	2	1
1	General format identifier				Logical Channel Group			
	0	0	0	1				
2	Logical Channel Number							
	Packet type identifier							
3	0	0	0	1	1	1	1	1

11.6 Restart Request and Restart Indication

	8	7	6	5	4	3	2	1
1	General format identifier							
	0	0	0	1	0	0	0	0
2	0	0	0	0	0	0	0	0
	Packet type identifier							
3	1	1	1	1	1	0	1	1
4	Restarting Cause							
5	Diagnostic Code							

11.7 Restart Confirmation

	8	7	6	5	4	3	2	1
1	General format identifier							
	0	0	0	1	0	0	0	0
2	0	0	0	0	0	0	0	0
	Packet type identifier							
3	1	1	1	1	1	1	1	1

APPENDIX A

NS REASON	NS ORIGINATOR	X.25 DIAGNOSTIC CODE Hex	decimal	CAUSE VALUE
disconnection-permanent condition	NS Provider	(E2)	226	0
disconnection-transient condition	NS Provider	(E1)	225	0
connection rejection-NSAP address unknown permanent	NS Provider	(E8)	232	0
connection rejection-NSAP unreachable transient	NS Provider	(E7)	231	0
connection rejection-QOS not available permanent	NS Provider	(E6)	230	0
connection rejection-QOS not available transient	NS Provider	(E5)	229	0
connection rejection-reason unspecified permanent	NS Provider	(E4)	228	0
connection rejection-reason unspecified transient	NS Provider	(E3)	227	0
disconnection- normal condition	NS User	(F1)	241	0
disconnection-abnormal condition	NS User	(F2)	242	0
connection rejection-permanent condition	NS User	(F5)	245	0
connection rejection-transient condition	NS User	(F4)	244	0
connection rejection-QOS not available permanent	NS User	(F7)	247	0
connection rejection-QOS not available transient	NS User	(F6)	246	0
connection rejection-incompatible information in NS-User Data	NS User	(F8)	248	0
undefined	--	(00)	0	0

TABLE 1 - NS Clear Reason to X.25 Diagnostic Code

X.25 CLEARING or RESTARTING CAUSE	CAUSE VALUE (Hex)	NS REASON	NS ORIGINATOR
Number busy	(1)	Connection rejection- NSAP unreachable transient	NS Provider
Out of order	(9)	* Connection rejection- reason unspecified permanent	NS Provider
		or Disconnection - permanent	NS Provider
Remote Procedure Error	(11)	* Connection rejection- reason unspecified permanent	NS Provider
		or Disconnection - permanent	NS Provider
Incompatible Destination	(21)	Connection rejection - reason unspecified permanent	NS Provider
Invalid Facility Request	(3)	Connection rejection - reason unspecified permanent	NS Provider
Access barred	(B)	Connection rejection - reason unspecified permanent	NS Provider
Local Procedure Error	(13)	* Connection rejection - reason unspecified transient	NS Provider
		or Disconnection - transient	NS Provider
Network Congestion	(5)	* Connection rejection - reason unspecified transient	NS Provider
		or Disconnection - transient	NS Provider
Not Obtainable	(D)	Connection rejection - NSAP address unknown permanent	NS Provider

TABLE 2 - X.25 Clearing/Restarting Cause to NS Reason

Note A1 :

A "disconnect" reason should only be derived from this table if the NC has already been established. Otherwise the "connection" rejection reason should be taken.

NS REASON	NS ORIGINATOR	X.25 DIAGNOSTIC CODE Hex decimal		CAUSE VALUE
Reason Unspecified	NS Provider	(E9)	233	0
Congestion	NS Provider	(EA)	234	0
User Resynchronization	NS User	(FA)	250	0

TABLE 3 - NS Reset Reason to X.25 Diagnostic Code

X.25 CLEARING or RESTARTING CAUSE	CAUSE VALUE (Hex)	NS REASON	NS ORIGINATOR
Remote Procedure Error	(3)	Reason Unspecified	NS Provider
Local Procedure Error	(5)	Reason Unspecified	NS Provider
Network Congestion	(7)	Congestion	NS Provider
Incompatible Destination	(11)	Reason Unspecified	NS Provider

TABLE 4 - X.25 Reset Cause to NS Reason

APPENDIX B

The state/event tables below assume a queuing model rather than a synchronous interface.

General Notes

These tables are use as follows :

1. Find the current State.
2. Find the row containing the Event which has occurred.
3. Is there an "x" in a column of the State. If not the Event is an error for the State. (Numbers instead of "x" indicate notes).
4. Follow the column down to find "x"s (or note numbers) in the Action area of the table. There may be more than one action.
5. Follow the row back to find the action.
6. Continue down the column to find the next State to be entered after the actions are performed.
7. The Action will normally result in an Event in the peer entity which will continue the cycle.
8. Remember that timers expiring are Events. Timer action + is Start or Reset. - is Stop.
9. The State/Event table contains a definitive answer for all events in a State.
10. It is assumed that the underlying X.25 system is operating correctly so no specific precautions are needed for X.25 error (eg. Data preceding Call Accepted).
11. The State/Event tables are split into two "phases" Connect phase and Data Transfer phase, mainly to simplify their presentation.

Notes for Connect Phase

1. The systems should remain in State 2 until a complete N-CC has been received either as a single packet or as a Complete Packet Sequence.
2. Call Collision. Abort both incoming and outgoing calls.
3. For received X.25 Data packets with both the Q and M bits set to 1, the X.25 N-CR, N-CC or N-DR event occurs when the Complete Packet Sequence has been completely received.
4. This State in the Connect phase encompasses all the states of the Data Transfer phase.

Connect Phase

STATES / EVENTS	1 IDLE						2 WAITING N-CC						3 WAITING CONN-RESP					
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
SERVICE PRIMITIVES																		
N-Connect-Request			X							X							X	
N-Connect-Response						X				X				X				
N-Disconnect-Req.						X				X								X
PROTOCOL MESSAGES																		
X.25 Call-Conn						X											X	
X.25 Data (N-CC) (3)						X		1									X	
X.25 Inc-Call				X						2							X	
X.25 Data (N-CR) (3)						X				X							X	
X.25 Clear-Ind						X					X					X		
X.25 DCE Clear-Conf						X				X							X	
X.25 Data (N-DR) (3)						X				X							X	
PROVIDER INIT. CLEAR						X				X							X	
TIMERS																		
Connect Response Timer Expires						X				X							X	
Disconnect Response Timer Expires						X				X							X	
Any other Event						X				X							X	
ACTIONS																		
SERVICE PRIMITIVES																		
N-Connect-Indication																		
N-Connect-Confirm								X										
N-Disconnect-Ind										X	X					X	X	
PROTOCOL MESSAGES																		
X.25 Call-req			X															
X.25 Data (N-CR)																		
X.25 Call-Accept				X														
X.25 Data (N-CC)														X				
X.25 Clear Req										X							X	
X.25 DTE Clear-Conf											X					X		
X.25 Data (N-DR)																		X
TIMERS																		
Connect Resp Timer			+					-										
Disconnect Resp Timer										+							+	+
NEXT STATE			4	5		1		6		7	1			6		1	7	7

Connect Phase

STATES / EVENTS	4 WAITING X.25-CONN					
	1	2	3	4	5	6
SERVICE PRIMITIVES						
N-Connect-Request		X				
N-Connect-Response		X				
N-Disconnect-Request		X				
PROTOCOL MESSAGES						
X.25 Call-Conn	X					
X.25 Data (N-CC) (3)						
X.25 Inc-Call		X				
X.25 Data (N-CR) (3)		X				
X.25 Clear-Ind			X			
X.25 DCE Clear-Conf		X				
X.25 Data (N-DR) (3)		X				
PROVIDER INIT. CLEAR		X				
TIMERS						
Connect Response Timer Expires		X				
Disconnect Response Timer Expires		X				
Any other Event		X				
ACTIONS						
SERVICE PRIMITIVES						
N-Connect-Indication						
N-Connect-Confirm						
N-Disconnect-Ind		X	X			
PROTOCOL MESSAGES						
X.25 Call-Req						
X.25 Data (N-CR)	X					
X.25 Call-Accept						
X.25 Data (N-CC)						
X.25 Clear Req		X				
X.25 DTE Clear-Conf			X			
X.25 Data (N-DR)						
TIMERS						
Connect Resp Timer			-			
Disconnect Resp Timer						
NEXT STATE	2	1	1			

Connect Phase

STATES / EVENTS	5 WAITING N-CR						6 DATA TRANSFER (note 4)						7 WAITING CLEAR-CONF					
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
SERVICE PRIMITIVES																		
N-Connect-Request				X													X	
N-Connect-Response																	X	
N-Connect-Request			X						X								X	
PROTOCOL MESSAGES																		
X.25 Call-Conn			X									X					X	
X.25 Data (N-CC)(3)			X									X					X	
X.25 Inc-Call			X									X					X	
X.25 Data (N-CR)(3)	X											X					X	
X.25 Clear-Ind		X						X						X				
X.25 DCE Clear-Conf			X									X	X					
X.25 Data (N-DR)(3)			X							X							X	
PROVIDER INIT.CLEAR			X									X			X			
TIMERS																		
Connect Response Timer Expires			X														X	
Disconnect Response Timer Expires			X									X			X			
Any other Event			X									X					X	
ACTIONS																		
SERVICE PRIMITIVES																		
N-Connect-Ind	X																	
N-Connect-Confirm																		
N-Disconnect-Ind				X				X		X		X						
PROTOCOL MESSAGES																		
X.25 Call-Req																		
X.25 Data (N-CR)																		
X.25 Call-Accept																		
X.25 Data (N-CC)																		
X.25 Clear Req			X							X		X			X			
X.25 DTE Clear-Conf		X						X						X				
X.25 Data (N-DR)									X									
TIMERS																		
Connect Resp Timer																		
Disconnect Resp Timer			+						+	+		+		-	-			
NEXT STATE	3	1	7	5				1	7	7		7		1	1	1		7

Notes for the Data Transfer Phase

1. N-Expedited-Data is not supported.
2. N-Data-Acknowledgement Request and Indication do not require any extra protocol messages. They are local to each end of the connection, controlling the use of the X.25 sequence number acknowledgements.
3. This action is not performed if the Reset was originated by the Provider Initiated Reset event at this end of the connection.

Data Transfer Phase

STATES / EVENTS	6 DATA TRANSFER							8 USER RESET						9 SERVICE RESET					
	7	8	9	A	B	C	D	1	2	3	4	5	6	1	2	3	4	5	6
SERVICE PRIMITIVES																			
N-Data-Request	X										X					X			
N-Reset-Request			X									X							X
N-Reset-Response							X					X		X					
PROTOCOL MESSAGES																			
X.25 DCE-Data		X									X					X			
X.25 Reset-Ind				X					X									X	
X.25 DCE Reset-Conf						X		X									X		
PROVIDER INIT.RESET					X							X					X		
Any other Event							X			X					X				
ACTIONS																			
SERVICE PRIMITIVES																			
N-Data-Indication		X																	
N-Reset-Indication				X	X													X	
N-Reset-Confirm								3	X										X
N-Disconnect-Ind							X			X					X				
PROTOCOL MESSAGES																			
X.25 DTE-Data	X																		
X.25 DTE-Reset-Req			X		X														
X.25 DTE-Reset-Conf									X					3					
X.25 Clear Req							X			X					X				
X.25 Clear-Conf																			
TIMERS																			
Disconnect Response Timer							+			+					+				
DISCARD DATA											X					X			
NEXT STATE	6	6	8	9	A	6	7	6	6	7	8	8		6	7	9	9	9	6

Data Transfer Phase

STATES / EVENTS	A PROVIDER RESET					
	1	2	3	4	5	6
SERVICE PRIMITIVES						
N-Data-Request			X			
N-Reset-Request						X
N-Reset-Response	X					
PROTOCOL MESSAGES						
X.25 DCE-Data			X			
X.25 Reset-Ind				X		
X.25 DCE Reset-Conf		X				
PROVIDER INIT. RESET						X
Any other Event					X	
ACTIONS						
SERVICE PRIMITIVES						
N-Data-Indication						
N-Reset-Indication						
N-Reset-Confirm						
N-Disconnect-Ind					X	
PROTOCOL MESSAGES						
X.25 DTE-Data						
X.25 DTE-Reset-Req						
X.25 DTE-Reset-Conf						
X.25 Clear Req					X	
X.25 Clear-Conf						
TIMERS						
Disconnect Response Timer					+	
DISCARD DATA			X			
NEXT STATE	8	9	A	9	7	A