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**DATA NETWORKS AND
OPEN SYSTEM COMMUNICATIONS**

OPEN SYSTEMS INTERCONNECTION-GENERAL

USE OF X.25 TO PROVIDE THE OSI
CONNECTION-MODE NETWORK SERVICE
FOR ITU-T APPLICATIONS

ITU-T Recommendation X.223

(Previously "CCITT Recommendation")

FOREWORD

The ITU-T (Telecommunication Standardization Sector) is a permanent organ of the International Telecommunication Union (ITU). The ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Conference (WTSC), which meets every four years, establishes the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1 (Helsinki, March 1-12, 1993).

ITU-T Recommendation X.223 was revised by ITU-T Study Group 7 (1993-1996) and was approved under the WTSC Resolution No. 1 procedure on the 16th of November 1993.

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NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

CONTENTS

SUMMARY

Recommendation X.25 is used for many different types of applications. This Recommendation, X.223, shows how to use X.25 for OSI purposes by specifying a mapping of the appropriate elements of X.25 to/from the OSI Connection-mode Network Service defined in Recommendation X.213. This revision of X.223 corrects serveral minor errors and achieves complete interworking capability with the corresponding ISO/IEC 8878 Standard.

USE OF X.25 TO PROVIDE THE OSI CONNECTION-MODE NETWORK SERVICE FOR ITU-T APPLICATIONS[1)]

(Melbourne, 1988; revised at Geneva, 1993)

0   Introduction

This Recommendation defines the method for providing the OSI Connection-Mode Network Service (CONS) for ITU-T Applications through the use of the virtual call services of the X.25 Packet Layer Protocol (X.25 PLP). Particularly, it specifies a mapping between the elements of the X.25/PLP and the primitives of the OSI CONS specified in CCITT Rec. X.213 | ISO/IEC 8348. Clause 13 contains the requirements for systems claiming conformance to this Recommendation.

Appendix I provides additional considerations on the relationship between the X.25 protocol procedures and the CONS primitives.

Appendix II illustrates the use of X.25 Network Protocol Address Information (NPAI), i.e. the Address Field and the Address Extension Facilities.

Appendix III illustrates the use of X.25 transit delay facilities.

Appendix IV shows the relationship of the OSI CONS Quality of Service (QOS) parameters and performance parameters in the X.130-Series Recommendations.

This Recommendation is similar to ISO/IEC 8878; however, the two are currently published as separate documents. A list of technical differences is given in Appendix V.

The relationship between the X.25/PLP and the OSI CONS is shown in Figure 1. This relationship is described only in tenns of the Network Layer entities that provide the CONS. No discussion is given here to describe the actions of a Network Layer entity that only provides a relay function for a given network connection.
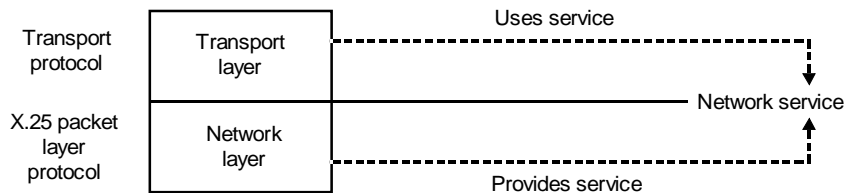
T0720140-94/d01

FIGURE 1/X.223

**Relationship of the X.25 Packet Layer Protocol
to the OSI Connection-Mode Network Service**

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[1)]   This Recommendation and ISO/IEC 8878:1992 were developed collaboratively and are similar in content. A list of technical differences is given in Appendix V.

The OSI Network Service is defined in terms of

- a) the primitive actions and events of the Service;

- b) the parameters associated with each primitive action and event, and the form which they take;

- c) the interrelationship between, and the valid sequences of, these actions and events.

The OSI Network Service does not specify individual implementations or products nor does it constrain the implementation of entities and interfaces within a computer system.

The X.25/PLP is defined in terms of

- a) procedures for Virtual Calls and Permanent Virtual Circuits;

- b) formats of packets associated with these procedures;

- c) procedures and formats for optional user facilities and CCITT-Specified DTE facilities.

The use of the word "Network" to name the "Network" Layer of the OSI Reference Model should be distinguished from the use of the word "network" to denote a communications network as conventionally understood. To facilitate this distinction, the term "subnetwork" is used for a collection of physical equipment, commonly called a "network" (reference CCITT Rec. X.200 | ISO 7498). Subnetworks may be either public or private networks. In the case of public networks, their properties may be determined by separate Recommendations such as CCITT Rec. X.21 for a circuit-switched network or ITU-T Rec. X.25 for a packet-switched network.

Thoughout the set of OSI-related Recommendations | International Standards, the term "Service" refers to the abstract capability provided by one layer of the OSI Reference Model to the layer above it. Thus, the Network Service is a conceptual architectural Service, independent of administrative divisions.

NOTE – It is important to distinguish the specialized use of the term "Service" within the set of OSI-related Recommendations | International Standards from its use elsewhere to describe the provision of a service by an organization (such as the provision of a service, as defined in ITU-T Recommendations, by an Administration).

1 Scope

The OSI CONS, as stated above, is defined in terms of a set of primitive actions and events and associated parameters. For a protocol to support this service, there must be a mapping between the abstract primitives and parameters of the CONS and the real elements of the protocol. This Recommendation provides such a mapping for the X.25/PLP using Virtual Calls.

The X.25/PLP is usually regarded as operating between an end system (i.e. a "Data Terminal Equipment" in X.25 terminology) and a packet-switched public data subnetwork. However, the X.25/PLP can also be used in other environments to provide the OSI CONS. Examples of such other uses include

- a) an end system connected to an X.25 packet-switched private data subnetwork;

- b) an end system connected to a local area network;

- c) direct connection or circuit-switched connection (including connection across a circuit-switched data subnetwork) of two end systems without an intervening packet-switched public data subnetwork;

- d) an end system connected to an Integrated Services Digital Network.

2 Normative References

The following Recommendations and International Standards contain provisions which, through reference in this text, constitute provisions of this Recommendations. At the time of publication, the editions indicated were valid. All Recommendations and Standards are subject to revision, and parties to agreements based on this Recommendation are

encouraged to investigate the possibility of applying the most recent edition of the Recommendations and Standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards. The TSB maintains a list of currently valid ITU-T Recommendations.

2.1 Identical Recommendations | International Standards

– ITU-T Recommendation X.210 (1993) | ISO/IEC 10731:1993, *Information Technology – Open Systems Interconnection – Basic Reference Model – Conventions for the definition of OSI services.*

– CCITT Recommendation X.213 (1992) | ISO/IEC 8348:1993, *Information Technology – Network Service Definition for Open Systems Interconnection.*

2.2 Paired Recommendations | International Standards Equivalent in Technical Content

– CCITT Recommendation X.200 (1988), *Reference model of Open Systems Interconnection for CCITT applications.*

– ISO 7498:1984, *Information processing systems – Open Systems Interconnection – Basic reference model.*

2.3 Additional References

– ITU-T Recommendation X.25 (1993), *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.*

   NOTE – This Recommendation is referred solely with respect to its Packet Layer Protocol description. However, this Recommendation fully specifies the behaviour of the DCE while specifying only a minimum set of requirements for the DTE. Additional guidance for the design of DTEs is available in ISO/IEC 8208.

– ITU-T Recommendation X.96 (1993), *Call progress signals in Public Data Networks.*

– ISO/IEC 8208:1990, *Information technology – Data communications – X.25 Packet Layer Protocol for data terminal equipment.*

3 Definitions

3.1 Reference Model Definitions

The following concepts, developed and defined in the OSI Reference Model (CCITT Rec. X.200 ISO 7498), are used:

a) Network connection;

b) Network Layer;

c) Network Service;

d) Network Service Access Point;

e) Network Service Access Point address;

f) Subnetwork.

3.2 Service Conventions Definitions

The following terms, as they apply to the Network Layer and as defined in the OSI Service Conventions (ITU-T Rec. X.210 | ISO/IEC 10731), are used:

a) Network Service user;

b) Network Service provider;

c) primitive;

d) request;

e) indication;

f) response;

g) confirm.

3.3   Network Service Definitions

The following terms, as defined in the Network Service (CCITT Rec. X.213 | ISO/IEC 8348), are used:

a) Calling Network Service user;

b) Called Network Service user;

c) Subnetwork Point of Attachment address;

d) Network Protocol Address Information;

e) Initial Domain Part;

f) Authority and Format Identifier;

g) Initial Domain Identifier;

h) Domain Specific Part;

3.4   X.25 Definitions

The following concepts, as developed in the X.25 Packet Layer Protocol (ITU-T Rec. X.25 and ISO/IEC 8208), are used:

a) virtual circuit;

b) Virtual Call;

e) logical channel;

d) Packet Layer;

e) Data Terminal Equipment;

f) Data Circuit-tetminating Equipment;

g) DXE (either a DTE or a DCE).

3.5   X.96 Definitions

The following terms, as defined in ITU-T Rec. X.96, are used:

a) Category C call progress signal;

b) Category D call progress signal.

4   Abbreviations

4.1   Network Service Abbreviations

AFI   Authority and Format Identifier

CONS   Connection-Mode Network Service

DSP   Domain Specific Part

IDI   Initial Domain Identifier

IDP   Initial Domain Part

N   Network

NC   Network-connection

NL   Network Layer

NPAI	Network Protocol Address Information
NS	Network Service
NSAP	Network Service Access Point
OSI	Open Systems Interconnection
QOS	Quality of Service
SNPA	Subnetwork Point of Attachment

4.2   X.25 Abbreviations

AEF	Address Extension Facility
AF	Address Field
B-MTCN	Basic Minimum throughput Class Negotiation (Facility)
B-TCN	Basic Throughput Class Negotiation (Facility)
D-bit	Delivery Confirmation bit
DCE	Data Circuit-terminating Equipment
DTE	Data Terminal Equipment
EDN	Expedited Data Negotiation (Facility)
EETDN	End-to-End Transit Delay Negotiation (Facility)
FPF	Facility Parameter Field
GFI	General Format Identifier
LC	Logical Channel
M-bit	More Data bit
MBS	M-bit Sequence
PLP	Packet Layer Protocol
P(R)	Packet receive sequence number
P(S)	Packet send sequence number
Q-bit	Qualifier bit
TDSAI	Transit Delay Selection And Indication (Facility)
VC	Virtual Call

5   Overview

The Network Service (NS) provides for the transparent transfer of data between NS users. lt makes invisible to these NS users the way in which supporting communications resources are utilized to achieve this transfer.

5.1   Elements of the X.25 | PLP Used to Support the OSI CONS

The X.25/PLP, as defined by ITU-T Rec. X.25 and ISO/IEC 8208, provides a specific realization for the transparent transfer of data between NS users of the CONS. The elements of this protocol to be considered are:

a)   the virtual-circuit types;

b)   the packet types and fields to be mapped to the primitives and parameters of the OSI CONS;

c)   the optional user facilitics and ITU-T-Specified DTE facilities.

Of the two types of virtual circuits defined in ITU-T Ree. X.25 and ISO/IEC 8208, the use of Virtual Calls (VCs) is mapped to the network connection (NC) establishment and release phases of the OSI CONS in clauses 6 and 7 and to the data transfer phase in clauses 8.1.

Table 1 lists the X.25/PLP packets and associated fields that shall be used when supporting the OSI CONS.

TABLE 1/X.223

Packets and fields of the X.25/PLP used to support the OSI CONS

Packet Types [a]	Field [b]
CALL REQUEST INCOMING CALL CALL ACCEPTED CALL CONNECTED	General Format Identifier [c], Address Field, Facility Field, Call and Called User Data Field [d]
CLEAR REQUEST CLEAR INDICATION	Clearing Cause Field, Diagnostic Code Field, Address Field, Facility Field, Clear User Data Field [d]
DATA	D-bit, M-bit, P(S) [e], P(R) [e], User Data Field [d]
INTERRUPT	Interrupt User Data Field [d]
RECEIVE READY [f] RECEIVE NOT READY [f] REJECT [f] (if agreed to)	P(R) [e]
RESET REQUEST RESET INDICATION	Resetting Cause Field, Diagnostic Code Field
RESTART INDICATION	Restarting Cause Field, Diagnostic Code Field

[a] The packets shown in the table are used in support of the primitives of the OSI CONS. Other packets not shown in the table (i.e. CLEAR CONFIRMATION, INTERRUPT CONFIRMATION, RESET CONFIRMATION, and RESTART CONFIRMATION packets) are essential to the use of the packets shown. Yet other packets (i.e. RESTART REQUEST, DIAGNOSTIC, REGISTRATION REQUEST, and REGISTRATION CONFIRMATION packets) have no relationship to the provision of the OSI CONS.

[b] The information in the fields shown in the table have a direct relationship to the parameters associated with the primitives of the OSI CONS. Other fields not shown in the table (e.g., the Logical Channel Identifier, the Packet Type Identifier, the Q-bit the Address Length Fields, and the Facility Length Field) are essential to the use of the appropriate packets.

[c] Bit 7 of octet I of the General Format Identifier (GFI) in these packets is used to negotiate the overall availability of the Delivery Confirmation bit (D-bit) in support of the Receipt Confirmation Service. As such, this bit has no specific field-name as defined in the X.25/PLP.

[d] All user data fields are octet aligned.

[e] The P(S) and P(R) fields are essential to the operation of the X.25/PLP in providing the Receipt Confirmation Service.

[f] The action implied by these packets has no relationship to the primitives of the OSI CONS. However, the P(R) field is essential to the operation of the X.25/PLP in providing the Receipt Confirmation Service.

In addition, the following optional user facilities and ITU-T Specified DTE facilities shall be used and/or agreed to:

    a)   optional user facilities:

         1)   Fast Select (facility used; when operating in a DTE-to-DTE environment without an intervening packet-switched network, the use of the Fast Select Facility shall also be agreed to by the two DTEs);

         2)   Fast Select Acceptance (facility agreed to if operating in a packet-switched network environment);

         3)   Basic Throughput Class Negotiation (facility agreed to and used);

         4)   Transit Delay Selection And Indication (facility used; use of this facility is for further study when operating in a DTE-to-DTE environment without an intervening packet-switched network).

    b)   ITU-T-Specified DTE facilities:

         1)   Called Address Extension (facility used);

         2)   Calling Address Extension (facility used);

         3)   End-to-End Transit Delay Negotiation (facility used);

         4)   Expedited Data Negotiation (facility used);

         5)   Basic Minimum Throughput Class Negotiation (facility used);

         6)   Priority (facility used, with 1988 or later versions of the X.25/PLP).

5.2   General Operation of the X.25 | PLP for Supporting the OSI CONS

The X.25/PLP can be used to provide the OSI CONS in an end system connected to a public or private X.25 packet-switched subnetwork. lt can also be used in environments where the end system is connected to a Local Area Network or where end systems are connected by a dedicated path or by a circuit-switched connection.

As shown in Figure 2, the NS provider [more particularly, the Network Layer (NL) entity in an end system] must provide a translation between

    a)   the primitives and parameters of the OSI CONS;

    b)   the packets and associated fields of the X.25/PLP.

Request and response primitives are translated into packets to be transmitted across the DTE/DXE interface by the NL entity. Received packets, where appropriate, are translated by the NL entity into indication and confirm primitives.

Appendix I provides additional considerations on the relationship between the X.25 protocol procedures and the CONS primitives.

         NOTE – The Network Service Definition specifies valid sequences of primitives at an NC endpoint and valid parameter responses at the called NC endpoint to Receipt Confirmation negotiation, Expedited Data negotiation, and Quality of Service (QOS) parameter negotiation. The necessity for the NL entity to monitor compliance and the actions to be taken on non-compliance are a local matter, and not subject to standardization.

There is also a relationship between some local mechanism used to identify a particular NC and a Logical Channel (LC) number used to identify a particular virtual circuit. This relationship is a local matter and is not discussed here.

6   Network Connection Establishment Phase

6.1   Primitive/Parameter and Packet/Field Relationships

Table 2 shows the relationships between the primitives/parameters used during the NC establishment phase and the packets/fields associated with the call setup procedures.

End System A   End System B
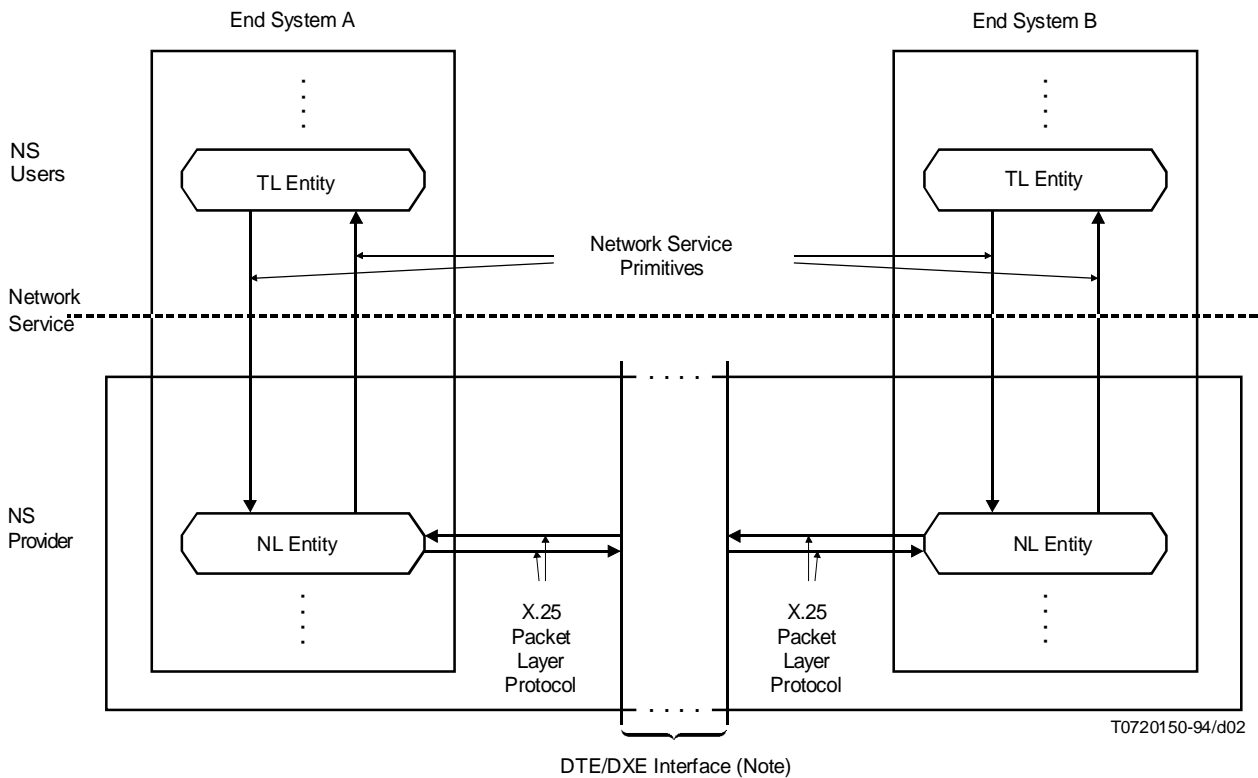
NOTE – This interface consists of zero or more Network Layer entities providing a Network Layer relay function.

FIGURE 2/X.223

Operation of OSI Connection-Mode Network Service and X.25 Packet Layer Protocol

6.2   Procedures

6.2.1   Primitive/Packet Mapping

When an NL entity receives an N-CONNECT request or an N-CONNECT response primitive from an NS user, it transmits a CALL REQUEST or a CALL ACCEPTED packet, respectively, across the DTE/DXE interface.

When an NL entity receives an INCOMING CALL or a CALL CONNECTED packet, it signals an N-CONNECT indication or an N-CONNECT confirm primitive, respectively, to the NS user.

6.2.2   Network Addresses

Local operation determines the contents of the Network Protocol Address Information (NPAI) and whether Network Addresses, where explicitly supplied, are mapped to and from the Address Field (AF) or the Address Extension Facilities (AEF) of X.25/PLP call setup packets. Appendix 11 describes guidelines for the methods by which the required AF contents may be derived from the Network Address. The permitted techniques for the placement of Network Addresses in either the AF or AEF are given in this subclause. The encoding techniques to be employed are those specified in ITU-T Rec. X.25 and ISO/IEC 8208 for the AF and AEF. The content of these fields shall be in the preferred binary encoding defined in CCITT Rec. X.213 | ISO/IEC 8348. Examples of encoding Network Addresses in the NPAI of the X.25/PLP are also given in Appendix II.

TABLE 2/X.223

CONS – X.25/PLP mapping for the N C establishment phase

CONS	X.25/PLP
PRIMITIVES	PACKETS
N-CONNECT request	CALL REQUEST
N-CONNECT indication	INCOMING CALL
N-CONNECT response	CALL ACCEPTED
N-CONNECT confirm	CALL CONNECTED
PARAMETERS	FIELDS (INCLUDING FACILITIES)
Called Address	Called DTE Address Field Called Address Extension Facility
Calling Address	Calling DTE Address Field Calling Address Extension Facility
Responding Address	Called DTE Address Field Called Address Extension Facility
Receipt Confirmation Selection	General Format Identifier [a]
Expedited Data Selection	Expedited Data Negotiation Facility
QOS-Parameter Set	Basic Throughput Class Negotiation Facility [b] Basic Minimum Throughput Class Negotiation Facility Transit Delay Selection And Indication Facility End-to-End Transit Delay Negotiation Facility Priority Facility
NS-User-Data	Call and Called User Data Field Fast Select Facility [c]

[a]   Bit 7 of octet 1 of the GFI in call setup packets is used to negotiate the overall availability of the D-bit in support of the Receipt Confirmation Service. As such, this bit has no specific field-name as defined in the X.25/PLP.

[b]   For proper operation, this optional user facility shall also be agreed to for use on the interface.

[c]   For proper operation, the Fast Select Acceptance Facility shall also be agreed to on the interface when accessing a packet-switched network.

6.2.2.1   Encoding of Network Addresses

6.2.2.1.1 Use of the Address Field (AF)

Under certain conditions, the Network Address, as defined in CCITT Rec. X.213 | ISO/IEC 8348, shall be conveyed entirely in the AF. These conditions are:

a)   the Network Address consists solely of the Initial Domain Part (IDP) (i.e. the Domain Specific Part (DSP) is null);

b)   the Authority and Format Identifier (AFI) can be deduced from the contents of the AF (e.g. with knowledge of the subnetwork to which the DTE is attached);

c)   the Initial Domain Identifier IDI is the same as the Subnetwork Point of Attachment (SNPA) Address;

d)   the NL entity, through local knowledge, is aware that the remote NL entity does not operate according to this Recommendation and cannot recognize the AEF.

When all of the above conditions are satisfied, the AF shall be used to convey the semantics of the entire Network Address (the AFI is implied and the contents of the AF are equivalent to the IDI).

> NOTE – The use of the preferred binary encoding results in binary-coded decimal digits in the AF, as required by ITU-T Rec. X.25 and ISO/IEC 8208.

6.2.2.1.2 Use of the AEF

If any of the conditions in 6.2.2.1.1 are not satisfied, the AEF shall be used. The Network Address, complete with AFI, is placed in the AEF (bits 8 and 7 of the first octet of the Facility Parameter Field (FPF) of the AEF are both set to zero). In this case, the contents of the AF are not defined by this Recommendation. Guidelines for their derivation are given in Appendix II.

6.2.2.2   Decoding of Network Addresses

If, after decoding the Network address as specified in the subclauses below, the Network address does not exist, then the NL entity clears the call by transmitting a CLEAR REQUEST packet across the DTE/DXE interface with a clearing cause code of "DTE Originated." It is recommended that the diagnostic code value be set to 232 (or 224), "Connection Rejection – NSAP Unreachable (Permanent Condition)." The NL entity shall not signal any primitive to the NS User.

6.2.2.2.1 Absent AEF Case

If the AEF is not present, then local knowledge is required by the receiving NL entity to determine whether a Network Address is to be deduced from the content of the AF. If this local knowledge indicates that a Network Address is present, its abstract syntax is as follows:

    a)   the AFI is deduced from knowledge of the subnetwork from which the packet was received;

    b)   the IDI is the same as the contents of the AF;

    c)   the DSP is absent.

If insufficient local knowledge exists to derive a Network Address from a received AF-only Called Address in an INCOMING CALL packet, then the call is rejected by transmission of a CLEAR REQUEST packet across the DTE/DXE interface with a clearing cause code of "DTE Originated." The diagnostic code value shall be set to 232 "Connection Rejection – NSAP Unreachable (Permanent Condition)".

6.2.2.2.2 AEF Case

If the AEF is present and bits 8 and 7 of the leading octet of the FPF are both set to zero, then the Network Address is contained entirely within the AEF. The abstract syntax is as follows:

    a)   the AFI is contained within the first two digits of the AEF;

    b)   the IDI is the remainder of the IDP after any leading and trailing padding digits are discarded;

    c)   the DSP, if present, constitutes the remainder of the AEF content after any trailing padding digits are discarded.

If a Network Address cannot be derived from the Called AEF in an INCOMING CALL packet, then the call is rejected by transmission of a CLEAR REQUEST packet across the DTE/DXE interface with a clearing cause code of "DTE Originated." lt is recommended that the diagnostic code value be set to 232 (or 224) "Connection Rejection – NSAP Unreachable (Permanent Condition)."

6.2.3   Receipt Confirmation Selection

Bit 7 of octet 1 in the GFI of X.25/PLP call setup packets is mapped to/from the Receipt Confirmation Selection parameter of N-CONNECT primitives.

If the Receipt Confirmation Selection parameter of the N-CONNECT request primitive indicates "use of Receipt Confirmation," then the NL entity, if it can support the D-bit procedure as defined in 8.2.3 and 9.2.1, sets bit 7 of the GFI to 1 to indicate use of receipt confirmation during the data transfer phase. If "no use of Receipt Confirmation" is indicated or the NL entity cannot support the D-bit procedure, then bit 7 is set to 0.

When an NL entity receives an INCOMING CALL packet with bit 7 of the GFI set to 1 but it cannot support the D-bit procedure, it indicates "no use of Receipt Confirmation" in the Receipt Confirmation Selection parameter of the N-CONNECT indication primitive signaled to the Called NS user. Otherwise, if bit 7 of the GFI is set to 1 (respectively, 0), then the NL entity indicates "use (respectively, no use) of Receipt Confirmation" in the Receipt Confirmation Selection parameter of the N-CONNECT indication primitive signaled to the Called NS user.

When an NL entity receives an N-CONNECT response primitive with the Receipt Confirmation Selection parameter indicating "use (respectively, no use) of Receipt Confirmation," it sets bit 7 of the GFI in the CALL ACCEPTED packet to 1 (respectively, 0).

When an NL entity receives a CALL CONNECTED packet with bit 7 of the GFI set to 1 (respectively, 0), it indicates "use (respectively, no use) of Receipt Confirmation" in the Receipt Confirmation Selection parameter of the N-CONNECT confirm primitive signaled to the Calling NS user.

6.2.4   Expedited Data Selection

The Expedited Data Negotiation (EDN) Facility of the X.25/PLP is mapped to/from the Expedited Data Selection parameter of N-CONNECT primitives.

If the Expedited Data Selection parameter of the N-CONNECT request primitive indicates "use of Expedited Data," then the NL entity, if it can support the Interrupt procedure using 32-octet INTERRUPT packets, encodes the EDN Facility in the CALL REQUEST packet to indicate use of expedited data during the data transfer phase. If "no use of Expedited Data" is indicated or the NL entity cannot support 32-octet INTERRUPT packets, then the EDN Facility shall be omitted.

When an NL entity receives an INCOMING CALL packet with no EDN Facility or with the EDN Facility indicating use of expedited data but it cannot support 32-octet INTERRUPT packets, it indicates "no use of Expedited Data" in the Expedited Data Selection parameter of the N-CONNECT indication primitive signaled to the Called NS user. Otherwise, if the EDN Facility indicates use (respectively, no use) of expedited data, then the NL entity indicates "use (respectively, no use) of Expedited Data" in the Expedited Data Selection parameter of the N-CONNECT indication primitive signaled to the Called NS user.

When an NL entity receives an N-CONNECT response primitive with the Expedited Data Selection parameter indicating "use of Expedited Data," it encodes the EDN Facility in the CALL ACCEPTED packet to indicate use of expedited data. If the Expedited Data Selection parameter indicates "no use of Expedited Data," then the EDN Facility shall be omitted.

When an NL entity receives a CALL CONNECTED packet with the EDN Facility indicating use (respectively, no use) of expedited data, it indicates "use (respectively, no use) of Expedited Data" in the Expedited Data Selection parameter of the N-CONNECT confirm primitive signaled to the Calling NS user. If the CALL CONNECTED packet has no EDN Facility, then the NL entity indicates "no use of Expedited Data" to the Calling NS user.

6.2.5   QOS Parameter Set

The set of QOS parameters that are conveyed during the NC establishment phase consists of the following parameters:

   a)   the throughput for the direction of data transfer from the Calling NS user to the Called NS user;

   b)   the throughput for the direction of data transfer from the Called NS user to the Calling NS user;

   c)   the transit delay that applies to both directions of data transfer;

   d)   the priority of the data transferred on the NC (with respect to data transferred on other NCs);

   e)   the priority of gaining an NC;

   f)   the priority of keeping this NC.

For each of these parameters, a set of "subparameters" is defined as follows:

a) a "Target" value, which is the QOS value desired by the Calling NS user;

b) a "Lowest Quality Acceptable" value, which is the lowest QOS value agreeable to the Calling NS user;

c) an "Available" value, which is the QOS value the NS provider is willing to provide;

d) a "Selected" value, which is the QOS value to which the Called NS user agrees.

The set of values that can be specified for each subparameter is defined in every Network Service. This set includes the value "unspecified." lt may also include a value defined to be a "default value" that is mutually understood by the NS provider and an NS user as applying in the absence of particular values.

Appendix IV shows the relationship of the QOS parameters defined in the CONS and the performance-related parameters defined in X.130 Series Recommendations for use in packet-switched public data networks.

6.2.5.1   Throughput QOS Parameters

The Basic Throughput Class Negotiation (B-TCN) Facility and the Basic Minimum Throughput Class Negotiation (B-MTCN) Facility of the X.25/PLP are mapped to/from both Troughput QOS parameters of N-CONNECT primitives. The B-MTCN Facility may not always be needed, depending on the circumstances as specified below. The specific mapping of these X.25/PLP facilities to/from both sets of Throughput subparameters is given in Table 3.

The set of values that can be specified for each Throughput subparameter ranges from 75 bits per second through 192000[2] bits per second, inclusive. This set consists of the following discrete values: 75, 150, 300, 600, 1200, 2400, 4800, 9600, 19200, 48000, 64000, 128000, and 192000 bits per second. An NL entity supports either all of these values or a contiguous subset of them. The value "unspecified" is also allowed.

TABLE 3/X.223

Mapping of Throughput QOS subparameters to X.25/PLP Facilities

CONS		X.25/PLP	
Subparameter	Primitive	Facility	Packet
Target	N-CONNECT request	B-TCN	CALL REQUEST
Lowest Quality Acceptable	N-CONNECT request	B-MTCN	CALL REQUEST
Available	N-CONNECT indication	B-TCN	INCOMING CALL
Lowest Quality Acceptable	N-CONNECT indication	B-MTCN	INCOMING CALL
Selected	N-CONNECT response	B-TCN	CALL ACCEPTED
Selected	N-CONNECT confirm	B-TCN	CALL CONNECTED

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[2]   For the 1984 X.25/PLP, only throughputs up to 48000 bits per second are available. For the 1988 X.25/PLP, this set is extended to 64000 bits per second. For the 1992 X.25/PLP, this set is extended to 192000 bits per second.

6.2.5.1.1 Processing an N-CONNECT request Primitive

If an NL entity, when receiving an N-CONNECT request primitive, cannot support the Lowest Quality Acceptable throughput (i.e. the minimum throughput) when specified for either direction of data transfer, then it rejects the request. In this case, the NL entity does not transmit any X.25/PLP packet but it does signal an N-DISCONNECT indication primitive to the Calling NS user. The Originator parameter is "NS Provider." The Reason parameter is "Connection Rejection – QOS Not Available/Transient Condition," or "Connection Rejection – QOS Not Available/Permanent Condition" if the NL entity could never support the Lowest Quality Acceptable for either direction of data transfer.

If an NL entity, when receiving an N-CONNECT request primitive, can support the Lowest Quality Acceptable throughput when specified, for both directions of transfer, then for each direction of transfer it

      a)   encodes the Lowest Quality Acceptable value in the B-MTCN facility;

      b)   encodes the lesser of the Target value and the highest value that the NL entity is prepared to support in the B-TCN facility (as shown in Table 3).

If the Target subparameter (of either or both of the Throughput QOS parameters) is "unspecified," then the NL entity encodes the B-TCN Facility for the corresponding direction(s) of data transfer as the highest throughput rate supported by the NL entity. If the Lowest Quality Acceptable subparameter (of either or both of the Throughput QOS parameters) is "unspecified," then the NL entity encodes the B-MTCN Facility for the corresponding direction(s) of data transfer as 75 bits per second. The B-TCN and B-MTCN Facilities are transmitted across the DTE/DXE interface in a CALL REQUEST packet.

If the NL entity receives an N-CONNECT request primitive with the Lowest Quality Acceptable subparameter of both the Throughput QOS parameters as "unspecified," then the B-MTCN Facility shall not be included in the CALL REQUEST packet.

6.2.5.1.2 Processing an INCOMING CALL Packet

When receiving an INCOMING CALL packet with a B-MTCN Facility, an NL entity compares the minimum throughput value specified in the B-MTCN Facility for each direction of data transfer to the available throughput value specified in the B-TCN Facility. If, for either direction, the available throughput value is less than the minimum throughput value or if the NL entity cannot support the minimum throughput value, then the NL entity clears the call (i.e. transmits a CLEAR REQUEST packet). The cause is "DTE Originated" and the diagnostic is "Connection Rejection – QOS Not Available/Transient Condition," or "Connection Rejection "QOS Not Available/Permanent Condition" if the NL entity could never support the lowest throughput value (these diagnostics have values 229 and 230, respectively). Otherwise, the NL entity indicates, for both directions of data transfer, the Available and Lowest Quality Acceptable throughput values in the Throughput QOS parameters of the N-CONNECT indicadon primitive signaled to the Called NS user. The Available and Lowest Quality Acceptable subparameters are mapped from the B-TCN and B-MTCN Facilities, respectively, as shown in Table 3.

If an NL entity receives an INCOMING CALL packet without the B-MTCN Facility, then the NL entity indicates the value "unspecified" for the Lowest Quality Acceptable subparameters of both the Throughput QOS parameters of the N-CONNECT indication primitive signaled to the Called NS user. The Available subparameters of both the Throughput QOS parameters are mapped from the B-TCN Facility.

       NOTE – From a practical standpoint, the value "unspecified" can be taken to be 75 bits per second due to restrictions concerning the discrete values that can be signaled in the CALL ACCEPTED packet as listed in 6.2.5.1.

6.2.5.1.3 Processing an N-CONNECT response Primitive

When an NL entity receives an N-CONNECT response primitive, it encodes the Selected throughput values for both directions of data transfer, as given in the Throughput QOS parameters, in the B-TCN Facility returned in the CALL ACCEPTED packet.

6.2.5.1.4 Processing a CALL CONNECTED Packet

When an NL entity receives a CALL CONNECTED packet, it indicates the Selected throughput values for both directions of data transfer, as given in the B-TCN Facility, in the Throughput QOS parameters of the N-CONNECT confirm primitive signaled to the Calling NS user.

6.2.5.2 Transit Delay QOS Parameter

The Transit Delay Selection And Indication (TDSAI) Facility and the End-to-End Transit Delay Negotiation (EETDN) Facility of the X.25/PLP are mapped to/from the Transit Delay QOS parameter of N-CONNECT primitives.

The set of values that can be specified for each Transit Delay subparameter ranges from 1 millisecond through 65 534 milliseconds, inclusive, in increments of 1 millisecond. An NL entity supports either all of these values or a contiguous subset of them. The value "unspecified" is also allowed.

An NL entity in an end system shall be able to determine the cumulative transit delay attributable to the NS provider in that end system. This is the transit delay of the NL entity itself, all lower-layer entities, and the effects of the access line transmission rate.

Appendix III illustrates the use of the X.25 TDSAI and EETDN Facilities in support of the end-to-end negotiation of the Transit Delay QOS parameter.

6.2.5.2.1 Processing an N-CONNECT request Primitive

If an NL entity, when receiving an N-CONNECT request primitive, cannot support the Lowest Quality Acceptable transit delay (i.e. the maximum transit delay) when specified, then it rejects the request. In this case, the NL entity does not transmit any X.25/PLP packet but it does signal an N-DISCONNECT indication primitive to the Calling NS user. The Originator parameter is "NS Provider." The Reason parameter is "Connection Rejection – QOS Not Available/Transient Condition," or "Connection Rejection – QOS Not Available/Permanent Condition" if the NL entity could never support the Lowest Quality Acceptable transit delay.

If an NL entity, when receiving an N-CONNECT request primitive, can support the Lowest Quality Acceptable transit delay (i.e. the maximum transit delay) when specified, or when the Target transit delay is specified and the Lowest Quality Acceptable transit delay is unspecified, then:

    a)   The NL entity encodes the cumulative transit delay attributable to the NS provider in the calling end system in the "cumulative-transit-delay subfield" (i.e. octets 1 and 2) of the EETDN Facility.

    b)   If a Target transit delay is specified, then the NL entity encodes this value in the "target-transit-delay subfield" (i.e. octets 3 and 4) of the EETDN Facility (otherwise, this subfield is not used).

         NOTE 1 – According to CCITT Rec. X.213 | ISO/IEC 8348, the case where the Target transit delay is unspecified and the Lowest Quality Acceptable transit delay has a value other than unspecified is not permitted; logically, this case can be represented by the permitted assignment where an identical value is specified for both the Target and Lowest Quality Acceptable transit delays.

    c)   If a Lowest Quality Acceptable transit delay is specified, then the NL entity encodes this value in the "maximum-acceptable-transit-delay subfield" (i.e. octets 5 and 6) of the EETDN Facility (otherwise, this subfield is not used).

    d)   When the operational mode is DTE-to-DCE, if the Target transit delay is specified, then the NL entity encodes the value of the TDSAI Facility as being less than the Target transit delay minus the cumulative transit delay for the calling end system, otherwise, the TDSAI Facility is encoded with any value (i.e. it is not constrained by this Recommendation). When operating in a DTE-to-DTE environment, the usage of the TDSAI Facility is for further study.

NOTE 2 – Given a "routeing management information base," the NL entity can refine the value encoded in the TDSAI Facility. For example, the value of the TDSAI Facility could take into account whether networks other than packet-switched networks are traversed in reaching the called end system or whether the called end system is reachable directly in a point-to-point configuration.

If both the Target and Lowest Quality Acceptable transit delays are unspecified, then the NL entity shall omit the TDSAI Facility (if applicable) and omit the EETDN Facility. The TDSAI and EETDN Facilities (if present) are transmitted across the DTE/DXE interface in a CALL REQUEST packet.

NOTE 3 – The value of the TDSAI Facility in a CALL REQUEST packet in a DTE/DCE environment provides a guideline to the DCE for allocating resources. The final transit-delay value applicable to the Virtual Call may be less than, equal to, or greater than the value in the CALL REQUEST packet.

6.2.5.2.2 Processing an INCOMING CALL Packet

If an NL entity receives an INCOMING CALL packet without the EETDN Facility or without the TDSAI Facility, then the NIL entity indicates the Available transit-delay value in the Transit Delay QOS parameter of the N-CONNECT indication primitive signaled to the called NS user as being "unspecified." Otherwise (i.e. when both the EETDN and TDSAI Facilities are present), the NL entity computes the total NC transit delay as given below.

The total NC transit delay is determined by summing the values of

      a)   the TDSAI Facility;

      b)   the "cumulative-transit-delay subfield" (i.e. octets 1 and 2) of the EETDN Facility;

      c)   the transit delay attributable to the NS provider in the called end system.

NOTE – The procedure suggested here for computing the value of the total NC transit delay is the best an NL entity can do in the absence of any "external information." However, given a "routeing management information base," the NL entity can refine this value. For example, the transit delay attributable to the effects of the access line transmission rate is not included when the called end system is connected to the calling end system in a point-to-point configuration (these effects have been accounted for by the calling end system).

If the "maximum-acceptable-transit-delay subfield" (i.e. octets 5 and 6) of the EETDN Facility is present, then the NL entity compares the value in this "subfield" to the total NC transit delay computed above. If the total NC transit delay is greater than the maximum acceptable transit delay, then the NL entity clears the call (i.e. transmits a CLEAR REQUEST packet). The cause is "DTE Originated" and the diagnostic is "Connection Rejection – QOS Not Available/Transient Condition," or "Connection Rejection – QOS Not Available/Permanent Condition" if the NL entity could never support the maximum-acceptable transit delay (these diagnostics have values 229 and 230, respectively). Otherwise, if either

      a)   the total NC transit delay is less than or equal to the maximum-acceptable transit delay, or

      b)   the "maximum-acceptable-transit-delay subfield" of the EETDN Facility is not present,

then the NL entity indicates the Available transit-delay value (as given by the total NC transit delay computed above) in the Transit Delay QOS parameter of the N-CONNECT indication primitive signaled to the Called NS user.

6.2.5.2.3 Processing an N-CONNECT response Primitive

When an NL entity receives an N-CONNECT response primitive and if the INCOMING CALL packet had contained an EETDN Facility, then the NL entity encodes the total NC transit-delay value (as computed above) in the "cumulative-transit-delay subfield" (octets 1 and 2) of the EETDN Facility returned in the CALL ACCEPTED packet. Otherwise, if the INCOMING CALL packet did not contain an EETDN Facility, then no EETDN Facility is returned in the CALL ACCEPTED packet.

NOTES

1   There is no Transit Delay QOS Parameter in an N-CONNECT response primitive.

2   The EETDN Facility returned in a CALL ACCEPTED packet only contains the "cumulative-transit-delay subfield."

If an N-CONNECT response primitive is received by an NL entity subsequent to an N-CONNECT indication primitive signaled from the NL entity with the Available transit delay subparameter set to "unspecified," then the NL entity does not include the EETDN Facility in the CALL ACCEPTED packet.

6.2.5.2.4 Processing a CALL CONNECTED Packet

If an NL entity receives a CALL CONNECTED packet with an EETDN Facility, then it indicates the Selected transit-delay value, as given by the "cumulative-transit-delay subfield" of the EETDN Facility, in the Transit Delay QOS parameter of the N-CONNECT confirm primitive signaled to the Calling NS user. Otherwise, if the CALL CONNECTED packet did not contain an EETDN Facility, then the NL entity indicates the Selected transit-delay value in the Transit Delay QOS parameter of the N-CONNECT confirm primitive as being "unspecified."

6.2.5.3   Priority QOS Parameters

The Priority Facility of the X.25/PLP is mapped to/from the three Priority QOS parameters of N-CONNECT primitives.

The set of values that can be specified for each Priority subparameter ranges from 0 (lowest priority) to 14 (highest priority). An NL entity supports all of these values. The value "unspecified" is also allowed (encoded as 255 in the X.25/PLP).

6.2.5.3.1 Processing an N-CONNECT request Primitive

An NL entity that supports a choice of priority levels shall proceed as specified in 6.2.5.3.1.1. An NL entity that does not support a choice of levels shall procced as specified in 6.2.5.3.1.2.

6.2.5.3.1.1   Processing with Choice of Levels Supported

If an NL entity, when receiving an N-CONNECT request primitive, cannot support the Lowest Quality Acceptable priority for any of the three Priority QOS parameters, when specified, then it rejects the request. In this case, the NL entity does not transmit any X.25/PLP packet but it does signal an N-DISCONNECT indication primitive to the Calling NS user. The Originator parameter is "NS Provider." The Reason parameter is "Connection Rejection – QOS Not Available/Transient Condition," or "Connection Rejection – QOS Not Available/Permanent Condition" if the NL entity could never support the Lowest Quality Acceptable priority for one or more of the Priority QOS parameters.

If an NL entity, when receiving an N-CONNECT request primitive, can support the Lowest Quality Acceptable priority for all three Priority QOS parameters, when specified, or any of the Lowest Quality Acceptable Priority QOS parameters is unspecified, then the NL entity encodes the Priority Facility as follows:

a)   if the Lowest Quality Acceptable of a Priority QOS parameter is specified, its value is encoded in the subfield of the X.25/PLP Priority Facility designated to contain this subparameter; otherwise, this subfield of the facility is encoded as 255 (unspecified);

b)   if the Target of a Priority QOS parameter is specified, its value is encoded in the subfield of the X.25/PLP Priority Facility designated to contain this subparameter, otherwise, this subfield of the facility is encoded as 255 (unspecified).

If either the Target or the Lowest Quality Acceptable priority is specified for any of die Priority QOS parameters, then die resulting Priority Facility is transmitted across the DTE/DXE interface in a CALL REQUEST packet. Any subfield of die Priority Facility that contains the "unspecified" value (i.e. 255) may be omitted if, and only if, it is not followed by

a subfield containing a value other than "unspecified." If both the Target and Lowest Quality Acceptable priority are unspecified for all Priority QOS parameters, then no Priority Facility is transmitted.

6.2.5.3.1.2   Processing with Choice of Levels Not Supported

When an NL entity receives an N-CONNECT request primitive, it shall encode the Lowest Quality Acceptable and Target priority level for each Priority QOS parameter in the X.25/PLP Priority Facility for transmission across the DTE/DXE interface in a CALL REQUEST packet, unless both values of all parameters are unspecified, in which case it shall not transmit a Priority Facility.

6.2.5.3.2 Processing an INCOMING CALL Packet

An NL entity that supports a choice of priority levels shall proceed as specified in 6.2.5.3.2.1. An NL entity that does not support a choice of levels shall proceed as specified in 6.2.5.3.2.2.

6.2.5.3.2.1   Processing with Choice of Levels Supported

When receiving an INCOMING CALL packet, an NL entity determines the Available and Lowest Quality Acceptable subparameters to be used in the N-CONNECT indication primitive for each Priority QOS parameter as follows:

   a)   if the packet contains no Priority Facility, then both subparameters for each Priority QOS parameter are unspecified;

   b)   if the subfield of the Priority Facility designated to contain the Available subparameter for a Priority QOS parameter is present, then the value of this subparameter is as given in the subfield, otherwise, the value is unspecified;

   c)   if the subfield of the Priority Facility designated to contain the Lowest Quality Acceptable subparameter for a Priority QOS parameter is present, then the value of this subparameter is as given in the subfield, otherwise, the value is unspecified.

If, for any of the three Priority QOS parameters, the NL entity cannot support the Lowest Quality Acceptable priority, then the NL entity clears the call (i.e. transmits a CLEAR REQUEST packet). The cause is "DTE Originated" and the diagnostic is "Connection Rejection – QOS Not Available/Transient Condition," or "Connection Rejection – QOS Not Available/Permanent Condition" if the NL entity could never support the Lowest Quality Acceptable priority (these diagnostics have values 229 and 230, respectively). Otherwise, the NL entity indicates, for each Priority QOS parameter, the Available and Lowest Quality Acceptable priority values in the Priority QOS parameters of the N-CONNECT indication primitive signaled to the Called NS user.

6.2.5.3.2.2   Processing with Choice of Levels Not Supported

When an NL entity receives an INCOMING CALL packet, the values of the Available and Lowest Quality Acceptable priority-level subparameters for use in the N-CONNECT indication primitive for each Priority QOS parameter shall be the values signified by the Priority Facility in the packet (if present). The absence of a subfield in the Priority Facility corresponds to the value "unspecified." If the Priority Facility is not present in the INCOMING CALL packet, then the values of both subparameters of each Priority QOS parameter shall be "unspecified."

6.2.5.3.3 Processing an N-CONNECT response Primitive

When an NL entity receives an N-CONNECT response primitive, it encodes the Selected priority value, if specified, as given for each Priority QOS parameter, in the Priority Facility returned in the CALL ACCEPTED packet. Any subfield of the Priority Facility that contains the "unspecified" value (i.e. 255) may be omitted if, and only if, it is not followed by a subfield containing a value other than "unspecified." If the Selected priority value is unspecified for all Priority QOS parameters, then no Priority Facility is returned in the CALL ACCEPTED packet

6.2.5.3.4 Processing a CALL CONNECTED Packet

When an NL entity receives a CALL CONNECTED packet, it indicates the Selected priority value, as given in the Priority Facility (if present), for each Priority QOS parameter of the N-CONNECT confirm primitive signaled to the Calling NS user. The absence of a subfield in the Priority Facility corresponds to the value "unspecified." If the Priority Facility is not present in the CALL CONNECTED packet, then the Selected value of each Priority QOS parameter shall be "unspecified."

6.2.6   NS-User-Data

The Call User Data Field of X.25/PLP CALL REQUEST and INCOMING CALL packets is used to transfer the NS user-data of N-CONNECT request and indication primitives, respectively. The Called User Data Field of X.25/PLP CALL ACCEPTED and CALL CONNECTED packets is used to transfer the NS-user-data of N-CONNECT response and confirm primitives, respectively. In addition, the Fast Select Facility shall be indicated in the CALL REQUEST packet sent by the Calling NL entity.

7   Network Connection Release Phase

7.1   Primitive/Parameter and Packet/Field Relationships

Table 4 shows the relationships between the primitives/parameters used during the NC release phase and the packets/fields associated with the call clearing procedures.

TABLE 4/X.223

CONS – X.25/PLP mapping for the NC release phase

CONS	X.25/PLP
PRIMITIVES	PACKETS
N-DISCONNECT request N-DISCONNECT indication	CLEAR REQUEST CLEAR INDICATION, RESTART INDICATION [a], CLEAR REQUEST [b]
PARAMETERS	FIELDS (INCLUDING FACILITIES)
Originator and Reason	Cause and Diagnostic Code Fields [c]
NS-User-Data	Clear User Data
Responding Address	Called DTE Address Field Called Address Extension Facility

[a]   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 Layer Protocol being restarted. The Restarting Cause and Diagnostic Code Fields are then treated in the same manner as the Clearing Cause and Diagnostic Code Fields.

[b]   See 7.2.1, Paragraph 2.

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

7.2   Procedures

7.2.1   Primitive/packet Mapping

When an NL entity receives an N-DISCONNECT request primitive from an NS user, it transmits a CLEAR REQUEST packet across the DTE/DXE interface. If, however, the NL entity had previously transmitted a CLEAR REQUEST packet and signaled an N-DISCONNECT indication primitive to the NS user (because of a protocol error; see below), then it does not transmit another CLEAR REQUEST packet.

If an NL entity detects an error in the operation of the X.25/PLP for which its action is to clear the VC (e.g. a format error in an INCOMING CALL packet or a timeout condition), then it transmits a CLEAR REQUEST packet across the DTE/DXE interface. If the virtual circuit is associated with an NC, then it also signals an N-DISCONNECT indication primitive to the NS user.

If an NL entity, upon receipt of an INCOMING CALL packet, is to deflect the call, then it should include, in its CLEAR REQUEST packet, any necessary ITU-T-specified DTE facilities and user data that are to be present in the INCOMING CALL packet transmitted to the alternate DTE. lt shall also include the Call Deflection Selection Facility.

When an NL entity receives a CLEAR INDICATION packet (or a RESTART INDICATION packet), it signals an N-DISCONNECT indication primitive to the NS user. lt also transmits a CLEAR CONFIRMATION packet (or a RESTART CONFIRMATION packet) across the DTE/DXE interface. If, however, the NL entity had previously transmitted a CLEAR REQUEST packet for the NC (i.e. a clear collision), then it does not signal an N-DISCONNECT indication primitive to the NS user nor transmit a CLEAR CONFIRMATION packet.

> NOTE – If the received CLEAR INDICATION packet is in response to a previously-transmitted CALL REQUEST packet, the NL entity may retry the call if the Network Connection Establishment Delay has not been exceeded rather than immediately signaling an N-DISCONNECT indication primitive to its NS user. The NL entity may also use the clearing cause code (see 7.2.2) in the CLEAR INDICATION packet to determine whether to retry the call. That is, the reattempt may be successful if the clearing cause code is classified as Category C (see ITU-T Rec. X.96); on the other hand, a Category-D code indicates a problem of a more permanent nature. The time interval between and number of reattempted calls is a local matter. If multiple attempts at establishing the NC are all unsuccessful, then the Originator-parameter and Reason-parameter values finally signaled in the N-DISCONNECT indication primitive are a local matter.

If either NL entity wishes to disconnect an NC, it signals an N-DISCONNECT indication primitive to its NS user and transmits a CLEAR REQUEST packet across the DTE/DXE interface. If, however, the NL entity in the calling DTE cannot, for example, support the QOS parameters specified in an N-CONNECT request primitive or does not have an LC available to set up a VC, then it signals an N-DISCONNECT indication primitive to the Calling NS user but does not transmit a CLEAR REQUEST packet across the DTE/DXE interface.

7.2.2   Originator/Reason

The combination of Originator and Reason parameters of the N-DISCONNECT primitives is mapped to/from the combination of Clearing Cause (or Restarting Cause) and Diagnostic Code Fields.

The combination of the cause code "DTE Originated" (coded as all zeros) with a diagnostic in the set 241, 242, and 244-248 corresponds to an Originator-parameter value of "NS User." In this case, there is a one-to-one relationship between the values of the Reason parameter and these diagnostic codes.

The cause code "DTE Originated" (coded as all zeros) used in combination with diagnostic codes other than those listed above corresponds to an Originator-parameter value of "NS Provider." There is a one-to-one relationship between the values of the Reason parameter and diagnostic codes 225-232 and 235.

In other cases, the Originator-parameter and Reason-parameter values depend on

        a)   the cause and/or diagnostic codes;

        b)   whether the NC is in the NC establishment phase or in the data transfer phase.

The values of the Originator and Reason parameters are derived as given below:

a) The Originator-parameter value is "NS Provider" and the Reason-parameter value is "Disconnection – Permanent Condition" when the NC is in the data transfer phase and any of the following applies:

1) cause codes "Out Of Order," "Local Procedure Error," "Remote Procedure Error," or "ROA Out Of Order;"

2) diagnostic code 122.

b) The Originator-parameter value is "NS Provider" and the Reason-parameter value is "Disconnection – Transient Condition" when the NC is in the data transfer phase and any of the following applies:

1) cause code "Network Congestion;"

2) diagnostic codes 113 or 115;

3) cause code "DTE Originated" (coded as all zeros) with diagnostic codes 162 or 163.

c) The Originator-parameter value is "NS Provider" and the Reason-parameter value is "Connection Rejection – NSAP Address Unknown (Permanent Condition)" when the NC is in the NC establishment phase and any of the following applies:

1) cause codes "Not Obtainable" or "Ship Absent."

d) The Originator-parameter value is "NS Provider" and the Reason-parameter value is "Connection Rejection – Reason Unspecified/Permanent Condition" when the NC is in the NC establishment phase and any of the following applies:

1) cause codes "Access Barred," "Fast Select Acceptance Not Subscribed," "Incompatible Destination," "Invalid Facility Request," "Out Of Order," "Local Procedure Error," "Remote Procedure Error," "Reverse Charging Acceptance Not Subscribed," or "ROA Out Of Order;"

2) diagnostic codes 121 or 122;

3) cause code "DTE Originated" (coded as all zeros) with diagnostic code 164.

e) The Originator-parameter value is "NS Provider" and the Reason-parameter value is "Connection Rejection-Reason Unspecified/Transient Condition" when the NC is in the NC establishment phase and any of the following applies:

1) cause codes "Network Congestion" or "Number Busy;"

2) diagnostic codes 112-120;

3) cause code "DTE Originated" (coded as all zeros) with a diagnostic code other than 162-164, 225-232, 235, 241, 242, and 244-248.

f) The Originator-parameter and Reason-parameter values are both "Undefined" for any other combination of cause and diagnostic codes.

7.2.3   NS-User-Data

The Clear User Data Field of X.25/PLP CLEAR REQUEST and CLEAR INDICATION packets is used to transfer the NS-user-data between NS users.

7.2.4   Responding Address

Local operation determines the contents of the Called Address Field and whether the responding Network Address, where explicitly supplied, is mapped to/from the AF or the AEF in X.25/PLP call clearing packets. Rules for encoding and decoding the responding Network Address are given in 6.2.2.

8 Data Transfer Phase – Data Transfer Service

8.1 Primitive/Parameter and Packet/Field Relationships

Table 5 shows the relationships between the primitives/parameters used for the data transfer service and the packets/fields associated with the data transfer procedures.

Table 5/X.223

CONS – X.25/PLP mapping for the data transfer service

CONS	X.25/PLP
PRIMITIVES	PACKETS
N-DATA request	DATA
N-DATA indication	DATA
PARAMETERS	FIELDS
NS-User-Data	User Data, M-bit
Confirmation Request	D-bit, P(S)

8.2 Procedures

8.2.1 Primitive/Packet Mapping

When an NL entity receives an N-DATA request primitive from an NS user, it transmits a sequence of one or more DATA packets, known as an M-bit Sequence (MBS), across the DTE/DXE interface. The number of DATA packets needed in an MBS depends on the amount of NS-user-data and on the maximum "packet size" (i.e. the maximum User Data Field Length of DATA packets) permitted on the DTE/DXE interface. All DATA packets but the last one of an NBS contain the maximum number of octets, have their M-bit set to 1, and have their D-bit set to 0. The last DATA packet has its M-bit set to 0. The D-bit setting of the last DATA packet is dependent on the Confirmation Request parameter (see 8.2.3 below). All DATA packets shall have the Q-bit set to zero.

When an NL entity receives an MBS with the Q-bit set to zero in each DATA packet, it signals an N-DATA indication primitive to the NS user.

8.2.2 NS-User-Data

The User Data Fields of X.25/PLP DATA packets are used to transfer NS-user-data between NS users.

8.2.3 Confirmation Request

The D-bit of the last DATA packet in an MBS is mapped to/from the Confirmation Request parameter.

If an N-DATA request primitive indicates in the Confirmation Request parameter that confirmation of receipt is requested (respectively, not requested), then the D-bit of the last DATA packet in an MBS is set to 1 (respectively, 0). In the case of confirmation of receipt being requested, the NL entity shall use a locally-defined mechanism to associate the P(S) of the last DATA packet in the MBS with the N-DATA request primitive. (This mechanism shall also provide for an association of an N-DATA request primitive with an N-DATA ACKNOWLEDGE indication primitive; see 9.2.1.)

When an NL entity signals an N-DATA indication primitive to the NS user, it indicates in the Confirmation Request parameter that confirmation of receipt is requested (respectively, not requested) if the D-bit of the last DATA packet in an MBS is set to 1 (respectively, 0). When the last DATA packet in an MBS has its D-bit set to 1, the NL entity shall not transmit a P(R) corresponding to that DATA packet across the DTE/DXE interface until it receives an N-DATA ACKNOWLEDGE request primitive from its NS user (see clause 9). In the case of the D-bit of the last DATA packet in an MBS being set to 1, the NL entity shall use a localiy-defined mechanism to associate the P(S) of this packet with the N-DATA indication primitive. (This mechanism shall also provide for an association of an N-DATA indication primitive with an N-DATA ACKNOWLEDGE request primitive: see 9.2. l.)

9   Data Transfer Phase – Receipt Confirmation Service

9.1   Primitive and Packet/Field Relationships

There is no distinct X.25/PLP packet associated with the N-DATA ACKNOWLEDGE request and N-DATA ACKNOWLEDGE indication primitives. The P(R) field of DATA, RECEIVE READY, RECEIVE NOT READY, and REJECT (if agreed to) packets is used to support the Receipt Confirmation Service.

9.2   Procedures

9.2.1   Primitive/Packet Mapping

When an NL entity receives an N-DATA ACKNOWLEDGE request primitive from an NS user, it uses its locally-defined mechanism mentioned in 8.2.3 for associating an N-DATA ACKNOWLEDGE request primitive with a previously-issued N-DATA indication primitive [and, hence, a P(S)] to determine a P(R) to be transferred in the appropriate packet across the DTE/DXE interface. (Note that such acknowledgements shall be issued in the same order that the corresponding N-DATA indications were issued.)

When an NL entity receives a P(R), it shall determine whether this P(R) is inclusive of a P(S) associated with a previously-received N-DATA request primitive that requested confirmation of receipt. If such an association is made, then the NL entity signals an N-DATA ACKNOWLEDGE indication primitive to the NS user. This N-DATA ACKNOWLEDGE indication primitive is associated, by the locally-defined mechanism mentioned in 8.2.3, to the previously-received N-DATA request primitive that had requested confirmation of receipt.

9.2.2   Parameters

There are no parameters associated with the Receipt Confirmation Service.

10   Data Transfer Phase – Expedited Data Transfer Service

10.1   Primitive/Parameter and Packet/Field Relationships

Table 6 shows the relationships between the primitives/parameters used for the Expedited Data Transfer Service and the packets/fields associated with the interrupt transfer procedures.

10.2   Procedures

10.2.1   Primitive/Packet Mapping

When an NL entity receives an N-EXPEDITED DATA request primitive from an NS user, it transmits an INTERRUPT packet across the DTE/DXE interface. An NL entity shall not transmit a second INTERRUPT packet before an outstanding INTERRUPT packet has been confirmed by an INTERRUPT CONFIRMATION packet

TABLE 6/X.223

CONS – X.25/PLP mapping for the Expedited Data Transfer Service

CONS	X.25/PLP

PRIMITIVES
 	
  N-EXPEDITED DATA request
 	
  N-EXPEDITED DATA indication
	PACKETS
	
	  INTERRUPT
	
	  INTERRUPT

PARAMETERS
 	
  NS-User Data
	FIELDS
	
	  Interrupt User Data

When an NL entity receives an INTERRUPT packet, it signals an N-EXPEDITED DATA indication primitive to the NS user. It also transmits an INTERRUPT CONFIRMATION packet across the DTE/DXE interface.

10.2.2   NS-User-Data

The Interrupt User Data Field of X.25/PLP INTERRUPT packets is used to transfer expedited NS-user-data between NS users.

11   Data Transfer Phase – Reset Service

11.1   Primitive/Parameter and Packet/Field Relationships

Table 7 shows the relationships between the primitives/parameters used for the Reset Service and the packets/fields associated with the reset procedures.

TABLE 7/X.223

CONS – X.25/PLP mapping for the Reset Service

CONS	X.25/PLP

PRIMITIVES
 	
  N-RESET request
 	
  N-RESET indication
 	
  N-RESET response
 	
  N-RESET confirm
	PACKETS
	
	  RESET REQUEST
	
	  RESET INDICATION, RESET REQUEST [a]
	
	  None
	
	  None

PARAMETERS
 	
  Originator and Reason
	FIELDS
	
	  Cause and Diagnostic Code Fields [b]

[a] See 11.2.1, Paragraph 2. [b] The combination of Cause and Diagnostic Code Fields is mapped to/from the combination of Originator and Reason parameters.	

## 11.2	Procedures

### 11.2.1	Primitive/Packet Mapping

When an NL entity receives an N-RESET request primitive from an NS user, it transmits a RESET REQUEST packet across the DTE/DXE interface. When the NL entity is ready to accept subsequent data, expedited data, and confirmations of receipt from the NS user, it signals an N-RESET confirm primitive. The issuing of this primitive may or may not be related to the completion of the X.25/PLP reset procedure. Any data or expedited data received from the NS user following the N-RESET confirm primitive is transmitted after completion of the X.25/PLP reset procedure.

If an NL entity detects an error in the operation of the X.25/PLP for which its action is to reset the virtual circuit (e.g. a sequence error or a timeout condition), then it transmits a RESET REQUEST packet across the DTE/DXE interface. When the NL entity is ready to accept subsequent data, expedited data, and confirmations of receipt from the NS user, it signals an N-RESET indication primitive. The issuing of this primitive may or may not be related to the completion of the X.25/PLP reset procedure. Any data or expedited data received from the NS user following the N-RESET response primitive is transmitted after completion of the X.25/PLP reset procedure.

When an NL entity receives a RESET INDICATION packet, it signals an N-RESET indication primitive to the NS user (except if this results in a reset collision; see below).

When an N-RESET response primitive is received from the NS user, the NL entity shall be willing to accept subsequent data, expedited data, and confirmations of receipt received from the NS user for transmission upon completion of the X.25/PLP reset procedure.

During the reset process, the following actions are taken by the NL entity with respect to the operation of the X.25/PLP:

    a)	For DATA packets:

        1)	those awaiting transmission may either be transmitted prior to transmitting a reset packet or flushed from the queue of DATA packets awaiting transmission,

        2)	those remaining in the transmit window when the reset procedure is completed are flushed; and

        3)	those that have been received prior to receiving a reset packet but which do not constitute an entire MBS are flushed from the "MBS reassembly area".

    b)	The lower window edge for each direction of data transmission is set to 0 and subsequently transmitted DATA packets are numbered starting from 0.

    c)	Any busy condition that had existed prior to the reset is considered not to exist any longer.

    d)	Any outstanding INTERRUPT packet remains unconfirmed.

    e)	All timer and retransmission parameters relating to data and interrupt transfer are set back to their initial values.

No action is required with respect to the provision of the Network Service by an NL entity when it receives a RESET CONFIRMATION packet or a RESET INDICATION packet in response to a RESET REQUEST packet (i.e. a reset collision). However, it shall then be capable of receiving subsequent DATA and INTERRUPT packets and P(R) information.

### 11.2.2	Originator/Reason

The combination of Originator and Reason parameters of the N-RESET primitives is mapped to/from the combination of Resetting Cause and Diagnostic Code Fields.

The combination of the cause code "DTE Originated" (coded as all zeros) with the diagnostic "Reset – User Resynchronization" (diagnostic code 250) corresponds to an Originator-parameter value of "NS User" and a Reason-parameter value identical to the diagnostic.

All other combinations of cause codes except "DTE Originated" coded as "10000000" and diagnostic codes specified in ITU-T Rec. X.25 and ISO/IEC 8208 correspond to an Originator-parameter value of "NS Provider." The value of the Reason parameter is derived as given below.

    a)   The Reason-parameter value is "Congestion" if any of the following applies:

        1)   cause code "Network Congestion;"

        2)   cause code "DTE Originated" (coded as all zeros) and diagnostic 234.

    b)   The Reason-parameter value is "Reason Unspecified" for any other combination of cause and diagnostic codes.

The cause code "DTE Originated" coded as "10000000" with any diagnostic code, as well as cause codes not specified in ITU-T Rec. X.25 and ISO/IEC 8208 with any diagnostic code, corresponds to values of both the Originator parameter and the Reason parameter of "Undefined."

12   Response to Protocol Violations

An NL entity may receive a packet that is valid according to ITU-T Rec. X.25 and ISO/IEC 8208 but is not valid when considered as part of the mapping specified in clauses 6 to 11. In such cases, it follows the actions given below.

    a)   Error Conditions:

        1)   INCOMING CALL packet without a B-TCN Facility,

        2)   CALL CONNECTED packet with a Selected QOS value, when present that is not valid with respect to the CALL REQUEST packet (e.g. the Selected value is less than the Lowest Quality Acceptable value);

        Whether receipt of an INCOMING CALL packet without a Fast Select Facility is an error condition is for further study.

        Actions:

        The NL entity shall transmit a CLEAR REQUEST packet across the DTE/DXE interface with a clearing cause code of "DTE Originated." lt is recommended that the diagnostic code be set to 228 (or 224). For condition (1), the NL entity shall not signal any primitive to the NS User; for condition (2), the NL entity shall signal an N-DISCONNECT indication primitive to the NS User.

    b)   Error Conditions:

        1)   DATA packet with its Q-bit set to 1;

        2)   DATA packet with its D-bit set to 1 when "no use of Receipt Confirmation" has been negotiated during NC establishment;

        3)   INTERRUPT packet when "no use of Expedited Data" has been negotiated during NC establishment.

        Actions:

        The NL entity shall transmit either of the packets given below across the DTE/DXE interface with a cause code of "DTE Originated." The Originator parameter of the resulting primitive signaled to the NS User, in either case, shall be "NS Provider."

    c)   Error Conditions:

        –   zero-length MBS.

        Actions:

        The NL entity shall ignore the zero-length MBS.

Packet to Transmit	Recommended Diagnostic Code	Primitive Signaled to NS User	Reason Parameter
CLEAR REQUEST	226 (or 224)	N-DISCONNECT indication	Disconnection – reason unspecified (permanent condition)
RESET REQUEST	233 (or 224)	N-RESET indication	Reset – reason unspecified

13 Conformance

13.1 Conformance Requirements

A system claiming to implement the procedures specified in this Recommendation shall

a)   support the procedures of the ITU-T Rec. X.25 Packet Layer Protocol;

b)   support all the packets and associated fields/facilities specified in Table 1 (excluding interrupt packets). Table 2 (excluding Expedited Data Negotiation), and Tables 4, 5 and 7, except that a system may support call setup packets relating to incoming calls only or to outgoing calls only;

c)   support all the optional user facilities and ITU-T (formerly CCITT)-specified DTE facilities specified in 5.1 except the EDN Facility;

d)   support the mapping of Network Service primitives to ITU-T Rec. X.25 and ISO/IEC 8208 packets in clauses 6 through 11,

e)   support the negotiation mechanism in 6.2.3 for the Receipt Confirmation Service;

f)   if it supports the optional Receipt Confirmation Service, support:

–   the procedures specified in 9;

g)   support the negotiation mechanism in 6.2.4, including the case when the EDN Facility is absent, for the Expedited Data Transfer Service;

h)   if it supports the optional Expedited Data Transfer Service, support:

1)   INTERRUPT packets with 32-octet User Data Fields and the procedures and mappings defined in clause 10;

2)   the EDN Facility;

i)   if all of the conditions defined in 6.2.2.1.1 are satisfied.

1)   encode and transmit the Network Address in the X.25/PLP Called/Calling Address Field;

2)   recognize the Network Address when it is received in the X.25/PLP Called/Calling Address Field;

j)   if any of the conditions defined in 6.2.2.1.1 is not satisfied:

1)   encode and transmit the Network Address in the X.25/PLP Called/Calling Address Extension Facilities;

2)   recognize the Network Address when it is received in the X.25/PLP Called/Calling Address Extension Facilities.

13.2 Optional Features

Clauses 6 to 11 allow certain options for implementations. Claims of conformance shall state

a)   whether Expedited Data Transfer is supported;

b)   whether Receipt Confirmation is supported.

Appendix I

Additional Considerations of CONS Primitives

(This appendix does not form an integral part of this Recommendation)

I.1 Introduction

This Recommendation presents a mapping between the CONS on the one hand and the X.25/PLP on the other. However, the designer of an end system should be aware that there are several issues related to the issuing of CONS primitives in addition to mapping them to X.25/PLP protocol elements. These issues relate to the provision of the appropriate "environment" (i.e. supporting protocols at appropriate layers) within the end system in which the X.25/PLP is to operate. The purpose of this appendix is to briefly describe these issues.

I.2 Environment for X.25/PLP Operation

For the purpose of this appendix, the environment in which the X.25/PLP operates depends on the technology of the subnetwork(s) to which the end system is attached. For example, the end system may be attached to a Local Area Network or to a packet-switched public data network. While the mapping between the primitives of the CONS and the elements of the X.25/PLP does not depend on the particular subnetwork, the proper provision of the environment for the X.25/PLP to operate does depend on it. The following subclauses illustrate the issues pertaining to provision of the environment in which the X.25/PLP operates. Complete details on these aspects are given in the following:

    a)   for LANS: ISO/IEC 8881:1989;

    b)   for ISDNS: CCITT Rec. X.612 (1992) | ISO/IEC 9574:1992;

    c)   for environments using X.21/X.21 *bis* (CSDN and an ISDN Terminal Adapter complying with Recommendation X.30): CCITT Rec. X.613 (1992) | IS0/1EC 10588:1992;

    d)   for the telephone network: CCITT Rec. X.614 (1992) | ISO/IEC 10732:1992.

I.2.1 Initialization

If, when receiving an N-CONNECT request primitive, the NL entity determines that the necessary subnetwork point of atttachment (SNPA) in this end system is not available (i.e. cannot be used for transmitting a CALL REQUEST packet), then appropriate procedures are necessary to be executed in the end system to make the SNPA available. Alternatively, the NL entity may reject the request. In this case, the corresponding procedures are not executed and the NL entity signals an N-DISCONNECT indication primitive to the Calling NS user. The Originator parameter is "NS Provider" and the Reason parameter is "Connection Rejection – Reason Unspecified/Permanent Condition."

    NOTE - lt is beyond the scope of this Recommendation to indicate how the NL entity determines whether the necessary SNPA is or is not available.

It is not the intent of this appendix to provide a complete set of procedures that are executed for the various subnetwork technologies in which the X.25/PLP may be used. Still, an example will provide an indication of these procedures.

Example – Connection of an End System to an X.25 Packet-Switched Data Network

Consider an end system connected to an X.25 packet-switched (public or private) data network by a dedicated line conforming to Recommendation X.21. If this interface is not available when an N-CONNECT request primitive is received by the NL entity, then the following steps are taken (in the order shown):

    a)   the X.21 establishment procedures are performed and the X.21 data transfer phase is entered;

    b)   the ISO 7776 protocol is executed to establish the Data Link Layer of the X.25 DTE/DCE interface and enter its data transfer phase;

    c)   the X.25/PLP restart procedure is executed.

Only after the successful completion of all three steps above can the NL entity transfer an X.25/PLP CALL REQUEST packet across the DTE/DCE interface.

It is also not the intent of this appendix to indicate how the NL entity is informed of the outcome of the initialization procedures. However, it is assumed that the NL entity is informed whether these procedures are successfully completed. The subsequent action of the NL entity depends on the outcome, for example:

a) *Successful lnidalizadon* – The NL entity transmits a CALL REQUEST packet; or

b) *Unsuccessful Initialization* – The NL entity may reattempt the initialization procedures again or signal an N-DISCONNECT indication primitive to the NS user but without transmitting a CLEAR REQUEST packet. In the latter case, the Originator parameter is "NS Provider." The Reason parameter is "Connection Rejection – Reason Unspecified/Transient Condition."

NOTE – A more detailed mapping of the Reason parameter to any diagnostic information available as a result of the failure of the initialization procedures may also be desired.

In a similar fashion as above for an N-CONNECT request primitive, it should be recognized that the initialization procedures must be completed before an N-CONNECT indication primitive can be signaled to an NS user.

I.2.2   Premature Closedown

If the environment in which the X.25/PLP operates prematurely closes down (i.e. while one or more NCs are established or in the process of being established), then the NL entity signals, for each established NC or NC in the process of being established, an N-DISCONNECT indication primitive to the NS user but does not transmit a CLEAR REQUEST packet. The Originator parameter is "NS Provider." The Reason parameter is:

a) for established NCs, "Disconnection – Transient Condition;" or

b) for NCs in the process of being established, "Connection Rejection – Transient Condition."

NOTE – A more detailed mapping of the reason parameter to any diagnostic information available as a result of the premature closedown may also be desired.

Appendix II

Use of X.25/PLP NPAI

(This appendix does not form an integral part of this Recommendation)

II.1   Introduction

This appendix discusses the use of X.25/PLP NPAI (i.e. the Address Field and the Address Extension Facilities). lt provides guidelines for obtaining the SNPA Address from the Network Address. lt also illustrates how a Network Address may be encoded in X.25/PLP NPAI.

II.2   Obtaining an SNPA Address

Two methods for obtaining an SNPA Address from a Network Address are described. The first one makes use of a directory, the second describes an algorithmic procedure. The two methods are not exclusive.

II.2.1   Directory

The directory is an abstract object which, given a Network Address, returns an SNPA Address. The operation of such a directory is not within the scope of this appendix. Conceptually, it may be viewed as a table look-up, a local directory, or a distributed directory. (For more information, consult CCITT Rec. X.650 (1992) | ISO/IEC 7498-3.)

II.2.2 Algorithmic Procedure

There are three cases that may be considered for deriving an SNPA Address from a Network Address:

    a)   DSP absent:

        1)   The Network Address is composed of an AFI and an IDI. If the AFI is consistent with the AFI format of the subnetwork provider, the IDI may be used directly in the Address Field subject to network-dependent prefixes and formats to provide the encoded SNPA Address. In this case, the AFI is not conveyed as explicit protocol control information. Its existence is thus implied and must be capable of being correctly deduced by the recipient.

        2)   In the case where the AFI format of the Network Address is not consistent with the subnetwork provider, it may be necessary to make use of a directory as described in II.2.1 above.

    b)   DSP present:

        The procedure to be followed in this case requires that the IDI and AFI be operated on as specified in Case a) above to determine the SNPA Address. The only difference for this case is that, in addition to the above, the complete Network Address is inserted in the AEF.

    c)   There may be cases, such as the use of escape digits (e.g. 8 = F.69, 9 = E.163), that do not require the use of directories. In cases such as this, the procedure defined in the appropriate addressing standard/recommendation (e.g. Recommendation X. 121 (1992)) may also be implied.

II.3 Examples of network Address Encoding

Below are several examples of how a Network Address is encoded in X.25/PLP NPAI (i.e. the AF and the AEF). Subclause 6.2.2 specifies how this encoding is performed. As indicated, the preferred binary encoding, as defined in CCITT Rec. X.213 | ISO/IEC 8348, is used as the encoding technique.

The examples make use of hexadecimal notation; that is $X'h_1h_2...'$ represents a string of hexadecimal digits. Padding digits are highlighted widi an underscore.

Example 1:

AFI	IDI	DSP
X'36'	X'313412345678'	null

Assuming the conditions in 6.2.2.1.1 are all satisfied, the above Network Address is conveyed in the AF. The AF would then be encoded as:

AF
X'313412345678'

Note that the need to include the Data Network Identification Code, which is 3134 in this example, and any prefix digits is a matter dependent on the packet-switched network to which the end system is attached.

Example 2:

AFI	IDI	DSP
X'37'	X'31341234567890'	X'5F4230A26789'

This Network Address can only be conveyed in the AEF. The encoding of the FPF of the AEF is as follows:

FPF of AEF

X'1C'	X'37313412345678905F4230A26789'

Example 3:

AFI	IDI	DSP
X'44'	X'123456789012345'	X'4297'

This Network Address can only be conveyed in the AEF. The encoding of the FPF of the AEF is as follows:

FPF of AEF

X'16'	X'441234567890123454297F'

Example 4:

AFI	IDI	DSP
X'45'	X'1234567890123'	X'FE496A'

This Network Address can only be conveyed in the AEF. The encoding of the FPF of the AEF is as follows:

FPF of AEF

X'18'	X'45001234567890123FFE496A'

Example 5:

AFI	IDI	DSP
X'47'	X'4368'	X'43678A4B095ECF'

This Network Address can only be conveyed in the AEF. The encoding of the FPF of the AEF is as follows:

FPF of AEF

X'14'	X'47436843678A4B095ECF'

Appendix III

Transit Delay Calculations

(This appendix does not form an integral part of this Recommendation)

This appendix illustrates how the various X.25 facilities are used to negotiate the end-to-end value of the transit delay QOS parameter.
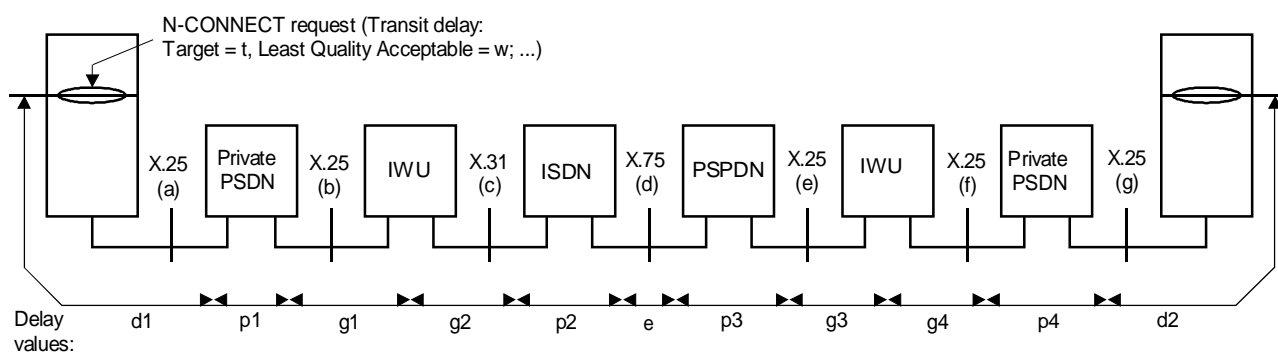
T0720160-94/d03

ISDN	Integrated Servives Digital Network
IWU	Interworking Unit
PSDN	Packet Switched Data Network
PSPDN	Packet Switched Public Data Network

The labels (a), (b), (c), (d), (e), (f), and (g) represent the various points between the entities involved in the scenario shown above at which the transit delay information is visible in the protocol control information.

	X.25 Facility	X.75 Utilities		EETDN Facility		
	TDSAI	TDS	TDI	CTD	TTD	MATD
Call Request Phase						
a) $t - d1 - dx$ (Note 1)	NA	NA	$d1$	t	w	
b) $p1$	NA	NA	$d1$	t	w	
c) $t - d1 - p1 - (g1 + g2) - dy$ (Note 1)	NA	NA	$d1 + p1 + (g1 + g2)$	t	w	
d) NA	$t - d1 - p1 - (g1 + g2) - dy$	$p2 + e$	$d1 + p1 + (g1 + g2)$	t	w	
e) $p2 + e + p3$	NA	NA	$d1 + p1 + (g1 + g2)$	t	w	
f) $t - (d1 + p1 + (g1 + g2)) - (g3 + g4) - (p2 + e + p3) - dz$ (Note 1)	NA	NA	$d1 + p1 + (g1 + g2) + (p2 + e + p3) + (g3 + g4)$	t	w	
g) $p4$	NA	NA	$d1 + p1 + (g1 + g2) + (p2 + e + p3) + (g3 + g4)$	t	w	

Call Confirmation Phase
(Note 2)

g) NA	NA	NA	d1 + p1 + (g1 + g2) + (p2 + e + p3) + (g3 + g4) + p4 + d2	NA	NA
f) p4	NA	NA	d1 + p1 + (g1 + g2) + (p2 + e + p3) + (g3 + g4) + p4 + d2	NA	NA
e) NA	NA	NA	d1 + p1 + (g1 + g2) + (p2 + e + p3) + (g3 + g4) + p4 + d2	NA	NA
d) NA	NA	p2 + e + p3	d1 + p1 + (g1 + g2) + (p2 + e + p3) + (g3 + g4) + p4 + d2	NA	NA
c) p2 + e + p3	NA	NA	d1 + p1 + (g1 + g2) + (p2 + e + p3) + (g3 + g4) + p4 + d2	NA	NA
b) NA	NA	NA	d1 + p1 + (g1 + g2) + (p2 + e + p3) + (g3 + g4) + p4 + d2	NA	NA
a) p1	NA	NA	d1 + p1 + (g1 + g2) + (p2 + e + p3) + (g3 + g4) + p4 + d2	NA	NA

CTD	Cumulative Transit Delay
EETDN	End-to-End Transit Delay Negotiation (Facility)
MATD	Maximum-Acceptable Transit Delay
NA	Not Applicable
TDI	Transit Delay Indication (Utility)
TDS	Transit Delay Selection (Utility)
TDSAI	Transit Delay Selection And Indication (Facility)
TTD	Target Transit Delay

NOTES

1   The values dx, dy, and dz represent an estimate of d2 included in the CAll REQUEST packet at interfaces a), c), and f), respectively, given an algorithm that may, for examp1e, make use of a "routeing management information base" to refine the value in the TDSAI Facility (see 6.2.5.2.1). In the absence of this algorithm, dx, dy, or dz would be zero.

2   The called DTE accepts the call if d1 + p1 + (g1 + g2) + (p2 + e + p3) + (g3 + g4) + p4 + d2 ≤ w. The Avai1able transit-de1ay value in the Transit Delay QOS parameter of the N-CONN-ECT indication primitive signaled to the Called NS user is d1 + p1 + (g1 + g2) + (p2 + e + p3) + (g3 + g4) + p4 + d2.

Appendix IV

Mapping of OSI CONS QOS parameters to parameters in the X.130 Series Recommendations

(This appendix does not form an integral part of this Recommendation)

This Recommendation describes the use of the X.25/PLP to provide the OSI Network Service defined in CCITT Rec. X.213 | ISO/IEC 8348, which uses various parameters to describe the quality of service obtained. The QOS parameters for PSPDNs are described in CCITT Recs. X.134, X.135, X.136, and X.137.

This appendix shows, in Table IV.1, the relationship between the various QOS parameters covered by CCITT Rec. X.213 | ISO/IEC 8348 and those used in CCITT Recs. X.135, X.136, and X.137. For completeness, this table lists all of the CCITT Rec. X.213 | ISO/IEC 8348 QOS parameters, even those that are not pertinent to the operation of this Recommendation.

TABLE IV.1/X.223

CCITT X.213	ISO/IEC 8348 Parameter	X.130 Parameter	Comments
NC establishment delay (Rec. X.213	ISO/IEC 8348, 10.2.1)	Call setup delay (Rec. X.135, 2)	(CCITT Rec. X.213	ISO/IEC 8348 includes an end system component; Rec. X.135 does not.
NC establishment failure probability (CCITT Rec. X.213 | ISO/IEC 8348, 10.2.2)	Call setup failure probability (Rec. X.136, 2.2) Call setup error probability (Rec. X.136, 2.1)	The same
Throughput (CCITT Rec. X.213 | ISO/IEC 8348, 10.2.3)	Throughput (Rec. X.135, 4)	CCITT Rec. X.213	ISO/IEC 8348 counts octets; CCITT Rec. X.135 counts user data bits. CCITT Rec. X.213	ISO/IEC 8348 includes both target and minimum values; Rec. X.135 has only minimum values.
Transit delay (CCITT Rec. X.213	ISO/IEC 8348, 10.2.4)	Data packet transfer delay (Rec. X.135, 3)	CCITT Rec.. X.213	ISO/IEC 8348 includes both target and maximum values; CCITT Rec. X.135 has only maximum values.
Residual error rate (CCITT Rec. X.213	ISO/IEC 8348, 10.2.5)	Residual error rate (Rec. X.136, 3.1)	CCITT Rec. X.213	ISO/IEC 8348 counts NSDUs in error; Rec. X.136 counts user data bits.
Transfer failure probability (CCITT Rec. X.213	ISO/IEC 8348, 10.2.6)	Availability (Rec. X.137)	They are similar: CCITT Rec. X.213	ISO/IEC 8348 does not include call setup, reset, and disconnect parameters; Rec. X.137 does not include transit delay.

CCITT X.213 | ISO/IEC 8348 Parameter	X.130 Parameter	Comments
NC resilience – provider release probability – provider reset probability (Rec. X.213 | ISO/IEC 8348, 10.2.7)	(Rec. X.136, 3.2, 3.3) – premature disconnect probability – reset probability	These are partially the same: CCITT Rec. X.213 | ISO/IEC 8348 lacks premature disconnect stimulus probability and reset stimulus probability (Rec. X.136, 3.2, 3.3).
NC release delay (CCITT Rec. X.213 | ISO/IEC 8348, 10.2.8)	Clear indication delay (Rec. X.135, 5)	The same
NC release failure probability (CCITT Rec. X.213 | ISO/IEC 8348, 10.2.9)	Call clear failure probability (Rec. X.136, 4)	The same, except that CCITT Rec. X.213 | ISO/IEC 8348 uses the maximum release delay and Rec. X.136 uses a different value from that.
NC protection (CCITT Rec. X.213 | ISO/IEC 8348, 10.2.10)	–	Not covered in Recs. X.130.
NC priority (CCITT Rec. X.213 | ISO/IEC 8348, 10.2.11)	–	Not covered in Recs. X.130.
Maximum acceptable cost (CCITT Rec. X.213 | ISO/IEC 8348, 10.2.12)	–	Not covered in Recs. X.130.

Appendix V

Differences between ITU-T Recommendation X.223 and ISO/IEC 8878

(This appendix does not form an integral part of this Recommendation)

ITU-T Recommendation X.223 (1993) is technically aligned with ISO/IEC 8878:1992 except for the following items.

a) In ITU-T Recommendation X.223, the text in 6.2.2.1.1 specifies that, under certain conditions, the Network Address is always carried in the AF whereas ISO/IEC 8878 leaves this as an option. ISO/IEC 8878 lists three conditions; ITU-T Recommendation X.223 lists these three plus a fourth, as follows: "the NL entity, through local knowledge, is aware that the remote NL entity does not operate according to ITU-T Recommendation X.223 and cannot recognize the AEF."

b) In ITU-T Recommendation X.223, the text in 6.2.4 specifies that if "no use of Expedited Data" is indicated or if the NL entity cannot support 32-octet INTERRUPT packets, then the EDN facility is always omitted. For the same case, ISO/IEC 8878 specifies that the EDN Facility either may be carried specifying "no use of Expedited Data" or may be omitted.

c) In 6.2.5.1 (Throughput QOS Parameters) of ITU-T Recommendation X.223, a new paragraph has been added that is not present in ISO/IEC 8878. This paragraph, which is the last paragraph in 6.2.5.1.1, specifies that whenever the Lowest Quality Acceptable subparameters of the Throughput QOS Parameters

for both directions are "unspecified" in the N-CONNECT request, the B-MTCN Facility is not included in the CALL REQUEST packet. ISO/IEC 8878 specifies that, in such a case, the B-MTCN Facility is encoded as 75 bits per second.

> NOTE – This difference does not affect interworking.

d) In 6.2.5.2 (Transit Delay QOS Parameter), ITU-T Rec. X.223 and ISO/IEC 8878 differ on handling some cases of transit delay negotiation. In 6.2.5.2.1 for ITU-T Rec. X.223, the TDSAI and EETDN Facilities are omitted from a CALL REQUEST packet when the Target and Lowest Quality Acceptable transit delays are "unspecified." ISO/IEC 8878 specifies that only the TDSAI Facility is omitted. In 6.2.5.2.2, an NL entity acts differently if either the TDSAI or EETDN Facility is absent from the INCOMINNG CALL packet: for ITU-T Rec. X.223, the NL entity specifies the Available transit delay as "unspecified;" for ISO/IEC 8878, the NL entity derives a value for the missing information.

> NOTE – This difference does not affect interworking.

Additionally, in 6.2.5.2.1 of ITU-T Recommendation X.223, the last sentence in item d) specifies that in DTE-to-DTE operational environments the TDSAI facility is for further study. ISO/IEC 8878 does not have such a sentence.

e) Both ITU-T Recommendation X.223 and ISO/IEC 8878 provide, in clause 12, a list of error conditions in the operation of the protocol. ISO/IEC 8878 includes receipt of a CALL CONNECTED packet without an EETDN Facility as an error condition; ITU-T Recommendation X.223 does not include this case. ISO/IEC 8878 considers receipt of an INCOMING CALL packet without a Fast Select Facility as an error while ITU-T Recommendation X.223 leaves this case for further study. Finally, ISO/IEC 8878, upon receipt of a zero-length MBS, allows an NL entity to clear or reset the call or ignore the MBS; ITU-T Recommendation X.223 only allows ignoring the MBS.

> NOTE - These differences do not affect interworking.

f) There are a few differences between ITU-T Recommendation X.223 and ISO/IEC 8878 in the conformance requirements of an NL entity. For ISO/IEC 8878, an NL entity must be capable of conveying a Network Address in the AEF; for ITU-T Recommendation X.223, the AEF is used only when the conditions in 6.2.2.1.1 are not satisfied. Also, conformance to ISO/IEC 8878 requires an indication of whether Annexes A and C (see below) are supported.

> NOTE - Theses differences do not affect interworking.

g) The scope of ITU-T Recommendation X.223 does not include for provision of the OSI Connection-mode Network Service over 1980 X.25 subnetworks. Conversely, ISO/IEC 8878 provides for this and defines a protocol mechanism in Annex A. Also, material related to interoperability issues, including those raised by the presence of Annex A, is included in Annex B to ISO/EEC 8878 and is not included in ITU-T Recommendation X.223.

h) The scope of ITU-T Recommendation X.223 does not include for provision of the OSI Connection-mode Network Service using Permanent Virtual Circuits. Conversely, ISO/IEC 8878 provides for this and defines a protocol mechanism in Annex C.

i) ISO/IEC 8878 contains a normative Annex D that specifies a Protocol Implementation Conformance Statement (PICS). ITU-T Recommendation X.223 does not contain this material.

j) ISO/EEC 8878 contains an informative Annex H that illustrates the use of priority-related facilities. ITU-T Recommendation X.223 does not contain this material.

k) ITU-T Recommendation X.223 contains an Appendix IV that shows the relationship between the various quality of service parameters covered by the Network Service and those used in the X.130-Series of Recommendations. ISO/IEC 8878 does not contain this material.