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Information technology — Data communications — X.25 Packet Layer Protocol for Data Terminal Equipment

Technologies de l'information — Communication de données — Protocole X.25 de couche paquet pour terminal de données

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) together form a system for worldwide standardization as a whole. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for approval before their acceptance as International Standards. They are approved in accordance with procedures requiring at least 75% approval by the national bodies voting.

International Standard ISO/IEC 8208 was prepared by Technical Committee ISO/IEC JTC 1, *Information technology*.

This second edition cancels and replaces the first edition (ISO 8208:1987).

Annex A forms an integral part of ISO/IEC 8208. Annex B is for information only.

Information technology — Data communications — X.25 Packet Layer Protocol for Data Terminal Equipment

1 Scope

This International Standard specifies the procedures, formats and facilities at the Packet Layer for Data Terminal Equipment (DTE) operating in conformance with CCITT Recommendation X.25. Both Virtual Call and Permanent Virtual Circuit modes of operation are covered.

The Packet Layer protocol specified herein can be used in both Open Systems Interconnection (OSI) and non-OSI environments. When used within the context of OSI, the Packet Layer protocol is encompassed in the Network Layer of the OSI Reference Model, ISO 7498.

This International Standard covers DTE operation at the Packet Layer when accessing a public or private packet-switched network conforming to CCITT Recommendation X.25 by means of a dedicated path or a circuit-switched connection. It also covers the additional Packet Layer procedures necessary for two DTEs conforming to this International Standard to communicate directly (i.e., without an intervening packet-switched network) over a dedicated path, a circuit-switched connection, or a local area network (LAN).

This International Standard also covers private networks that use CCITT Recommendation X.25 to connect to packet-switched public data networks and that may also offer an X.25 interface to a DTE (see annex A).

The first edition of this International Standard was based on the 1984 CCITT Red Book text of Recommendation X.25. It also contained the necessary provisions for compatibility with the earlier 1980 CCITT Yellow Book text of Recommendation X.25. This second edition is based on the 1988 CCITT Blue Book text of Recommendation X.25. Retained within this second edition are the necessary provisions for compatibility with the 1984 and 1980 versions of X.25. The differences between the first and second editions of this International Standard are summarized in annex B.

It should be noted that this International Standard and CCITT Recommendation X.25 as it applies to DTEs are different in scope. This International Standard contains the specifications that Recommendation X.25 places on DTEs. In addition, this International Standard contains added specifications to facilitate interworking between DTEs and to cover direct DTE-to-DTE operation. This broader scope has to be recognized in the application of this International Standard.

2 Normative references

The following standards and recommendations contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards and recommendations are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards and recommendations listed below. Members of IEC and ISO maintain registers of currently valid International Standards. The CCITT secretariat maintains a register of currently valid CCITT Recommendations.

ISO 7498 : 1984, *Information processing systems — Open Systems Interconnection — Basic Reference Model (see also CCITT Recommendation X.200, CCITT Blue Book, 1988).*

ISO 7776 : 1986, *Information processing systems — Data communications — High-level data link control procedures — Description of the X.25 LAPB-compatible DTE data link procedures.*

ISO 8348 : 1987, *Information processing systems - Data communications — Network service definition (see also CCITT Recommendation X.213, CCITT Blue Book, 1988).*

ISO 8348/Add. 2 : 1988, *Information processing systems — Data communications — Network service definition — Addendum 2: Network layer addressing (see also CCITT Recommendation X.213, CCITT Blue Book, 1988).*

ISO 8348/Add. 3 : 1988, *Information processing systems — Data communications — Network service definition — Addendum 3: Additional features of the network service (see also CCITT Recommendation X.213, CCITT Blue Book, 1988).*

ISO 8878 : 1987, *Information processing systems — Data communications — Use of X.25 to provide the OSI connection-mode network service (see also CCITT Recommendation X.223, CCITT Blue Book, 1988).*

ISO 8880-2 : 1990, *Information technology — Data communications — Protocol combinations to provide and support the OSI network service — Part 2: Provision and support of the connection-mode network service.*

ISO/IEC 8881 : 1989, *Information processing systems — Data communications — Use of the X.25 packet level protocol in local area networks.*

ISO/IEC 8886 : 1990, *Information technology — Data communications — Data link service definition for Open Systems Interconnection (see also CCITT Recommendation X.212, CCITT Blue Book, 1988).*

ISO/IEC 9574 : 1989, *Information technology — Telecommunications and information exchange between systems — Provision of the OSI connection-mode network service by packet mode terminal equipment connected to an Integrated Service Digital Network (ISDN).*

ISO/IEC TR 10029 : 1989, *Information technology — Telecommunications and information exchange between systems — Operation of an X.25 interworking unit.*

CCITT Recommendation D.12, *Measurement unit for charging by volume in the international packet-switched data transmission service, CCITT Blue Book, 1988.*

CCITT Recommendation X.2, *International data transmission services and optional user facilities in public data networks and ISDNs, CCITT Blue Book, 1988.*

CCITT Recommendation X.25, *Interface between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) for terminals operating in the packet mode and connected to public data networks by dedicated circuit, CCITT Blue Book, 1988.*

CCITT Recommendation X.29, *Procedures for the exchange of control information and user data between a packet assembly/disassembly (PAD) facility and a packet mode DTE or another PAD, CCITT Blue Book, 1988.*

CCITT Recommendation X.31, *Support of packet mode terminal equipment by an ISDN, CCITT Blue Book, 1988.*

CCITT Recommendation X.32, *Interface between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) for terminals operating in the packet mode and accessing a packet switched public data network through a public switched telephone network or an integrated services digital network or a circuit switched public data network, CCITT Blue Book, 1988.*

CCITT Recommendation X.96, *Call progress signals in public data networks, CCITT Blue Book, 1988.*

CCITT Recommendation X.244, *Procedure for the exchange of protocol identification during virtual call establishment on packet-switched public data networks, CCITT Blue Book, 1988.*

3 General considerations

This International Standard defines, from the viewpoint of a DTE, the Packet Layer, which governs the transfer of packets at a DTE/DCE or DTE/DTE interface.[1] On the transmitting side, the Packet Layer in a sending DTE performs the basic function of packetizing messages delivered by a higher layer entity in the same DTE before giving the information to a Data Link Layer protocol for transmission to a DXE. On the receiving side, the Packet Layer in a DTE performs the basic functions of receiving packets from the Data Link Layer, checking packets for correctness, stripping off packet headers, and formulating messages from the packetized user data and passing them to a higher layer entity in the DTE.

This International Standard presents a description of the Packet Layer for "Virtual Call" service and "Permanent Virtual Circuit" service.

The following information is presented:

a) general considerations (clause 3);

b) procedures for exchanging packets across a DTE/DXE interface (clauses 4 through 11). Clause 5 applies to the setup and clearing procedures for Virtual Call service, while the other clauses apply to both Virtual Call service and Permanent Virtual Circuit service;

c) packet formats (clause 12);

d) procedures for optional user facilities that may be available on a DTE/DXE interface (clauses 13 and 14);

e) formats for optional user facilities and registration-facilities (clauses 15 and 16, respectively);

f) coding of the Diagnostic Code Field (clause 17);

g) timers and retransmission counts (clause 18);

h) state diagrams and state tables (clauses 19 and 20, respectively); and

i) applications of this International Standard to private networks that connect to a packet-switched public data network and that may also offer an X.25 interface to a DTE (see annex A).

To facilitate comprehension of this International Standard, a number of conventions have been adopted in the presentation of the text:

a) the names of states and packets are in full capitals;

b) the names of the optional user facilities, packet fields, causes and diagnostics are in initial capitals;

c) *italicized text* is used to denote differences between Virtual Call and Permanent Virtual Circuit service and between DTE/DTE and DTE/DCE interfaces (entire clauses or subclauses that pertain to one service or to one interface type are not italicized; the appropriate environment is denoted at the beginning of the clause or subclause);

d) terms not explicitly defined within this International Standard are taken from the referenced CCITT X-series recommendations.

The Packet Layer procedures in this International Standard are based on an underlying service (for example, that provided by

1) The term "DXE" is used in those contexts where it would not matter whether a DTE or a DCE was being referred to. Therefore, this International Standard can be viewed as defining the Packet Layer at the DTE/DXE interface.

ISO 7776 or, more generally, the provision of the OSI Data Link Service defined in ISO/IEC 8886) that provides:

a) a negligible residual-bit-error rate;

b) a negligible out-of-sequence rate; and

c) a negligible packet-loss and duplication rate.

The Packet Layer provides the following functional capabilities that facilitate reliable and efficient data communications:

a) multiplexing — the ability to support multiple communications;

b) data transfer — the ability to send and receive data;

c) flow control — the ability to control the flow of data;

d) interrupt transfer — the ability to send and receive a small amount of information independent of the data stream;

e) error control — the ability to detect Packet Layer errors;

f) reset and restart — the ability to reinitialize communication paths in the event that Packet Layer errors are encountered.

A number of design principles were used in the formulation of the Packet Layer procedures for DTEs specified in this International Standard:

a) conform fully to CCITT Recommendation X.25 for operation with a packet-switched network;

b) minimize the differences between operating with a packet-switched network and operating directly with another DTE;

c) provide, where possible, the opportunity for recovery from an error condition without incurring data loss at the Packet Layer;

d) align the services provided by the Packet Layer with the Network Layer services defined for Open Systems Interconnection; and

e) follow the organization of text in CCITT Recommendation X.25.

3.1 Compatibility with versions of CCITT Recommendation X.25

The Packet Layer procedures and formats specified in this International Standard are compatible with the 1988 (Blue Book) version of CCITT Recommendation X.25.

NOTE — The TOA/NPI capability introduced into the 1988 version of CCITT Recommendation X.25 is not included in this International Standard since CCITT has designated it for further study.

For DTEs needing to operate with the earlier versions of Recommendation X.25, the following restrictions apply.

3.1.1 Limitations for compatibility with X.25-1984

For DTEs needing to operate with the 1984 (Red Book) version of Recommendation X.25, the following 1988 capabilities are not used:

a) *expanded capabilities for the following optional user facilities*

— *Network User Identification (NUI) related facilities (see 13.21),*

— *RPOA related facilities (see 13.23), and*

— *Call Redirection and Call Deflection related facilities (see 13.25);*

for 1984 operation, Call Deflection and NUI Override were not defined and the NUI and RPOA facilities were not explicitly separated into subscription and negotiation facilities;

b) the following CCITT-specified DTE facilities

— *Priority (see 14.5), and*

— *Protection (see 14.6);*

for 1984 operation the above facilities were not defined;

c) coding of the following CCITT-specified DTE facilities were modified

— *Called Address Extension (see 15.3.2.1), and*

— *Calling Address Extension (see 15.3.2.2);*

for 1984 operation only BCD encoding of the addresses is permitted.

d) the throughput class of 64 000 bit/s; for 1984 operation the largest throughput class is 48 000 bit/s.

3.1.2 Limitations for compatibility with X.25-1980

For DTEs needing to operate with the 1980 (Yellow Book) version of Recommendation X.25, the following 1984 capabilities are not used in addition to those cited in 3.1.1:

a) maximum User Data Field lengths in DATA packets of 2 048 and 4 096 octets (see 6.2); for 1980 operation, the largest maximum User Data Field length allowed is 1 024 octets;

b) *Facility Fields in CALL REQUEST, INCOMING CALL, CALL ACCEPTED,* and *CALL CONNECTED packets with a length from 64 to 109 octets (see 12.2.1.1 and 12.2.2.1); for 1980 operation, this field is limited to 63 octets and bit 7 of the Facility Length Field shall be set to 0;*

c) cause codes with bit 8 set to one in *CLEAR REQUEST/INDICATION,* RESET REQUEST/INDICATION, and RESTART REQUEST/INDICATION packets (see 12.2.3.1.1, 12.5.1.1, and 12.6.1.1, respectively); for 1980 operation, this bit shall be set to zero;

d) *nonzero Address Length and Facility Length Fields in CLEAR REQUEST and CLEAR INDICATION packets (see 12.2.3.2); for 1980 operation, these length fields shall indicate zero octets and may only be present when the packet contains a Clear User Data Field;*

e) *the extended format for CLEAR CONFIRMATION packets (see 12.2.4.2); for 1980 operation, only the basic format may be used;*

f) Interrupt User Data Fields in INTERRUPT packets containing from two to 32 octets (see 12.3.2); for 1980 operation, this field shall contain exactly one octet;

g) the following optional user facilities:

— On-line Facility Registration (see 13.1),

— *Local Charging Prevention (see 13.20),*

— *Network User Identification (see 13.21),*

— *Charging Information (see 13.22),*

— *Hunt Group (see 13.24),*

— *Call Redirection and Call Deflection Notification (see 13.25),*

— *Called Line Address Modified Notification (see 13.26), and*

— *Transit Delay Selection and Indication (see 13.27);*

for 1980 operation, the above facilities cannot be used;

h) *expanded capabilities for the following optional user facilities:*

— *Closed User Groups (CUG): subscription to the Closed User Group With Outgoing and/or Incoming Access Facilities without a preferential CUG (see 13.14.2 and 13.14.3, respectively), use of the extended format of the CUG Selection Facility for indicating membership in more than 100 CUGs (see 13.14.6), and the use of the Closed User Group With Outgoing Access (CUG/OA) Selection Facility (see 13.14.7); for 1980 operation, all CUG subscriptions shall specify a preferential CUG, only the basic format of the CUG Selection Facility is allowed for indicating membership in 100 or less CUGs, and the CUG/OA Selection Facility cannot be used,*

— *Fast Select and Fast Select Acceptance (see 13.16 and 13.17, respectively): inclusion of a Clear User Data Field in CLEAR REQUEST and CLEAR INDICATION packets after call setup has been completed; for 1980 operation, the above packets can contain a Clear User Data Field only when sent or received in direct response to an INCOMING CALL or a CALL REQUEST packet, respectively, and*

— *RPOA Selection (see 13.23): use of the extended format of the RPOA Selection Facility to select one or more RPOAs, and agreement for a period of time with the DCE to a set of RPOAs to pertain to all CALL REQUEST packets; for 1980 operation, a DTE wishing to select an RPOA can only do so in a CALL REQUEST packet and can only use the basic format of the RPOA Selection Facility to select a single RPOA; and*

i) *the CCITT-specified DTE facilities and the associated facility marker (see clause 14 and 15.1, respectively); for 1980 operation, these facilities and the marker cannot be used.*

3.2 Environments

The DTE aspects of the Packet Layer protocol set forth in this International Standard are applicable to a number of environments including:

a) DTE/DCE operation:

— DTE access to a DCE via a dedicated path,

— DTE access to a DCE via a circuit-switched connection (circuit-switched data network, circuit-switched capability of an Integrated Services Digital Network (ISDN), or the switched telephone network). Additional considerations are given in 3.4.

NOTES

1 The situation where the "DTE" is a private network accessing a public network DCE is covered in annex A.

2 The DCE may be a packet-switched data network operating in accordance with CCITT Recommendation X.25 or a packet handler capability in an ISDN operating in accordance with CCITT Recommendation X.31.

b) DTE/DTE operation:

— DTE-to-DTE operation over a leased line (data network, ISDN or telephone network),

— DTE-to-DTE operation over a circuit-switched connection (circuit-switched data network, circuit-switched capability of an ISDN, or the switched telephone network). Additional considerations are given in 3.4,

— DTE-to-DTE operation over a Local Area Network (LAN). The provisions of ISO/IEC 8881 apply.

NOTE 3 — The situation where a "DTE" is a gateway on the LAN to other networks is covered in annex A.

Differences between DTE/DCE and DTE/DTE operation are enumerated in 3.3.

3.3 Differences in DTE/DTE and DTE/DCE operation

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

a) *the Address Length Fields and the Facility Length Field shall be supplied in CALL ACCEPTED packets even if they indicate that no address and facility information, respectively, are present;*

b) the Diagnostic Code Field in RESTART REQUEST, *CLEAR REQUEST*, and RESET REQUEST packets shall be supplied even if it indicates "No Additional Information" (that is, although specific diagnostics are defined for particular error situations, a DTE may use more general codes as discussed in note 2 of table 25);

c) a DATA packet whose User Data Field is less than the maximum allowed and which has its D-bit set to 0 and M-bit set to 1 shall not be transmitted; and

d) upon notification that the Data Link Layer has completed its initialization procedures or that it has recovered from a failure in which the Data Link Layer was in the disconnected phase, the DTE shall transmit a RESTART REQUEST packet across the DTE/DXE interface.

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

a) *One of the DTEs shall act as a DCE for*

— *logical channel selection during Virtual Call setup (see figure 1),*

— *resolution of Virtual Call collision (see 5.2.5).*

(This choice is made independently for each of the DTE's Packet Layer entities; see 3.8.)

The restart procedure (see 4.5) may be used to determine which DTE acts as a DCE and which DTE maintains its role as a DTE with respect to the above items. (The procedures in 4.5 may be used in the general case of a DTE/DXE interface via a dedicated path or a circuit-switched connection. Alternatively, if a DTE is to operate only in a DTE/DCE environment or a DTE/DTE environment where, by administration, the roles can be predetermined and fixed, then the DTE may be initialized to act appropriately.)

b) A DTE shall be able to accept a RESTART INDICATION packet with a Restarting Cause Field of "DTE Originated," an event which does not occur in a DTE/DCE environment.

c) A DTE should not receive a RESTART, *CLEAR*, or RESET INDICATION packet with a Cause Field other than "DTE Originated" (although this may occur in a DTE/DCE environment). Therefore, the DTE may either handle such a packet as it does in a DTE/DCE environment (i.e., process the packet normally) or treat it as an error (DTE/DTE environment only).

d) A DTE may transmit a DIAGNOSTIC packet in the appropriate circumstances (see 11.1) only if it can suppress its generation when connected to a network.

e) *A DTE may ignore or treat as an error the receipt of facility codes that do not apply to a DTE/DTE environment.*

f) Use of the optional On-line Facility Registration Facility (see 13.1) requires agreement for each direction of registration-procedure initiation. That is, for a given direction of registration-procedure initiation, agreement to use this facility permits the initiating DTE to transmit REGISTRATION REQUEST packets and requires the responding DTE to process received REGISTRATION REQUEST packets. (In a DTE/DCE environment, a DTE will not receive a REGISTRATION REQUEST packet.)

g) Use of the optional Packet Retransmission Facility (see 13.4) requires agreement for each direction of transmission of DATA packets. That is, for a given direction of transmission of DATA packets, agreement to use this facility permits the destination DTE to transmit REJECT packets and requires the source DTE to process received REJECT packets. (In a DTE/DCE environment, a DTE will not receive a REJECT packet.)

h) *Use of optional Fast Select Facility (see 13.16) shall be agreed to by both DTEs prior to transmission of any call setup packets which utilize this facility. (In a DTE/DCE environment, such prior agreement is not required — a DTE may always use this facility at call setup.)*

i) *A called DTE which subscribes to the Flow Control Parameter Negotiation Facility (see 13.12) and/or the Throughput Class Negotiation Facility (see 13.13) will not receive, in an INCOMING CALL packet, a facility indication from which to negotiate if the calling DTE is satisfied with the default values and, thus, has not included the facility request in its CALL REQUEST packet. In a similar manner, a calling DTE which subscribes to these facilities will not receive, in a CALL CONNECTED packet, a facility indication if the called DTE is satisfied with the values in the INCOMING CALL packet and, thus, has not included a facility request in its CALL ACCEPTED packet. (In a DTE/DCE environment, these facility indications are always present if the DTE has subscribed to these facilities.)*

3.4 Operation over circuit-switched connections

When communications between a DTE and DXE involves a circuit-switched connection (e.g., through a circuit-switched data network, circuit-switched capability of an Integrated Services Digital Network, or through the switched telephone network), identification procedures may be required. Such procedures, including those at the Packet Layer, are defined in CCITT Recommendation X.32.

Most communications over a circuit-switched connection are between DTEs and DXEs that have been arranged, by some prior administrative procedure, to be compatible. Agreement must be reached, for example, as to what logical channels will be used, the window sizes to be used, and a number of other items pertaining to Packet Layer operation. In some cases, however, it may be desirable to allow for random communications, where a DTE accesses a DXE via a circuit-

switched connection without prior agreement (for example, an electronic mail-order service). To allow for this, the following subset of the Packet Layer procedures will be used:

a) the interface shall consist of a single two-way Virtual Call logical channel using Logical Channel Identifier 1;

b) the procedures described in 4.5 are required;

c) the default values for all applicable parameters listed in clause 18 shall apply; parameters T24, T25, T27, T28, R25, R27, and R28 and the procedures in 11.2, 11.3, 13.1, and 13.4 do not apply;

d) the reset procedures shall apply if erroneous DATA packets are received (see 11.3); and

e) no optional user facilities shall be allowed.

Extensions beyond this basic set of procedures and capabilities can be obtained through the use of procedures defined in CCITT Recommendation X.32.

3.5 Provision of the OSI Network Service

The Packet Layer protocol specified in this International Standard can be used to support the OSI connection-mode Network Service in a variety of environments (e.g., see ISO 8880-2). The Packet Layer protocol supports all the elements of the OSI connection-mode Network Service specified in ISO 8348 and its Addendum 3. Mappings to/from the Packet Layer protocol elements and the primitives and parameters of the connection-mode Network Service are described in ISO 8878. Additional provisions applicable in an ISDN environment are described in ISO/IEC 9574.

3.6 External Packet Layer interactions

The protocol described here is independent of any external considerations. However, the initiation of certain Packet Layer protocol procedures is directed by elements outside the protocol. Likewise, the occurrence of certain Packet Layer protocol events are to be reported appropriately. These external interactions include:

a) requesting, of the Data Link Layer, transmission of outgoing packets;

b) receiving, from the Data Link Layer, incoming packets;

c) accepting requests from a higher layer entity to initiate certain Packet Layer protocol procedures including:

— initialize the Packet Layer (see 4.1),

— *originate a Virtual Call (see 5.2.1),*

— *accept a Virtual Call (see 5.2.3),*

— *terminate a Virtual Call (see 5.5.1),*

— transfer data and interrupt information (see clause 6), and

— reinitialize a logical channel (see 8.1).

It is required that sufficient information be made available to the protocol to allow it to execute these procedures. Note that, in certain circumstances, the Packet Layer protocol can, on its own accord, *terminate* a *Virtual Call* or reinitialize a logical channel; and

d) reporting to a higher layer entity the occurrence of certain Packet Layer protocol events including:

— (re)initialization of all logical channels (see 4.2),

— *receipt of an incoming request to set up a Virtual Call (see 5.2.2),*

— *termination of a Virtual Call (see 5.5.2),*

— receipt of data and interrupt information (see clause 6), and

— reinitialization of a logical channel (see 8.2).

Along with the signal of their occurrence, the Packet Layer also provides to the higher layer entity any data associated with these events. In addition, the Packet Layer may also signal the status of the items listed in (c) above.

3.7 Logical channels

To enable simultaneous Virtual Calls and/or Permanent Virtual Circuits, logical channels are used. Each Virtual Call and Permanent Virtual Circuit is assigned a Logical Channel Identifier,[1] which is a number in the range from 1 through 4 095. *For each Virtual Call, a Logical Channel Identifier is assigned during the call setup phase from a range of previously agreed-upon Logical Channel Identifiers. For each Permanent Virtual Circuit, a Logical Channel Identifier is assigned in agreement with the DXE.* (Logical Channel Identifier 0 shall not be assigned to a Virtual Call or a Permanent Virtual Circuit.)

A DTE's use of logical channels is agreed upon for a period of time with the DXE. Figure 1 shows the structure for assigning logical channels used for Virtual Calls and Permanent Virtual Circuits.

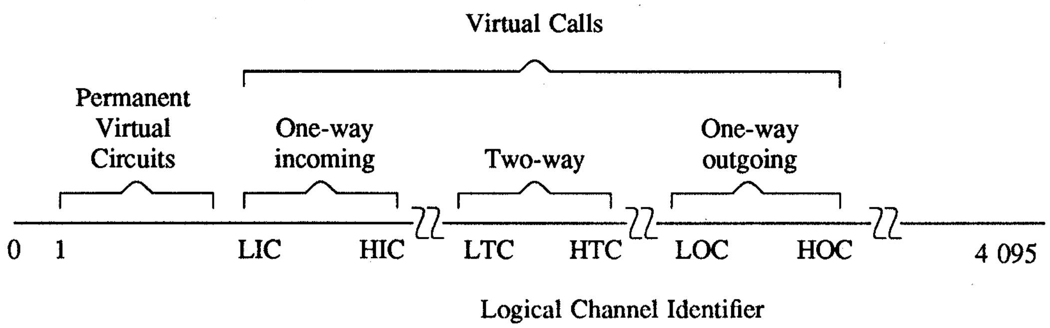
3.8 Packet Layer entity

The concept of communication via logical channels is native to Packet Layer terminology. It is conceivable, however, that a DTE may have one or more connections to one or more packet networks and/or to one or more DTEs without an intervening packet network. At this point, therefore, it is necessary to introduce the concept of a "Packet Layer entity." One such

1) A logical channel may be identified as one 12-bit field or two subfields containing 4 and 8 bits, respectively. When viewed as one field, the term "Logical Channel Identifier" or just "logical channel" is used; when viewed as two fields, the terms "logical channel group number" (4 bits) and "logical channel number" (8 bits) are used. The one-field interpretation will be used within this International Standard.

In the case of a single logical channel DTE/DXE interface, logical channel 1 will be used.

In the case of a multiple logical channel DTE/DXE interface, a range of logical channels will be agreed to according to the following diagram:



LIC: Lowest Incoming Channel
HIC: Highest Incoming Channel
LTC: Lowest Two-way Channel
HTC: Highest Two-way Channel
LOC: Lowest Outgoing Channel
HOC: Highest Outgoing Channel

Logical channels 1 through LIC-1: range of logical channels which may be assigned to Permanent Virtual Circuits

Logical channels LIC through HIC: range of logical channels which are assigned as one-way incoming for Virtual Calls

Logical channels LTC through HTC: range of logical channels which are assigned as two-way for Virtual Calls

Logical channels LOC through HOC: range of logical channels which are assigned as one-way outgoing for Virtual Calls

Logical channels HIC+1 through LTC-1, HTC+1 through LOC-1, and HOC+1 to 4 095 are non-assigned logical channels

NOTES

1 The reference to the Logical Channel Identifiers is made according to a set of contiguous numbers from 0 (lowest) to 4 095 (highest) using the 12 bits made up of bits 4 through 1 of octet 1 and all bits of octet 2 of each packet (see 12.1.2). The numbering is binary-coded using bit positions 4 through 1 of octet 1 followed by bit positions 8 through 1 of octet 2, where bit 1 of octet 2 is the low-order bit.

2 Logical Channel Identifier 0 shall not be assigned to a Virtual Call or Permanent Virtual Circuit.

3 All logical channel boundaries are agreed upon with the DXE for a period of time.

4 In a DTE/DTE environment, one DTE views the range of Logical Channel Identifiers as presented here, whereas the other DTE views it as a DCE (e.g., the latter DTE views the range from LIC to HIC as one-way *outgoing*). This determination is discussed in 4.5.

5 In order to avoid frequent rearrangement of logical channels, not all logical channels within the range for Permanent Virtual Circuits are necessarily assigned.

6 In the absence of Permanent Virtual Circuits, logical channel 1 is available for LIC. In the absence of Permanent Virtual Circuits and one-way incoming logical channels, logical channel 1 is available for LTC. In the absence of Permanent Virtual Circuits, one-way incoming logical channels, and two-way logical channels, logical channel 1 is available for LOC.

7 The search algorithm of a DCE, or a DTE playing the role of a DCE in a DTE/DTE environment, for a logical channel for a new incoming call will be to use the lowest numbered logical channel in the READY state (p1) in the range of LIC to HIC and LTC to HTC.

8 In order to minimize the risk of call collision, the DTE search algorithm starts with the highest numbered logical channel in the READY state (p1) in the two-way logical channel or one-way outgoing logical channel ranges.

Figure 1 — Logical Channel Identifier Assignment

entity exists in a DTE for each DTE/DTE (without an intervening packet network) interface or for each DTE/DCE (packet network) interface. This is illustrated in figure 2. Deciding which entity to use to reach a particular destination is a function performed external to the protocol described here. The protocol discussed in this International Standard pertains to each Packet Layer entity in a DTE.

3.9 Packet types

Packet types and their use with Virtual Call and Permanent Virtual circuit services are given in table 1.

3.10 Procedures for initialization

Initialization of the Packet Layer corresponds to initialization of each logical channel in the Packet Layer entity. Prior to initial data transmission on any logical channel, the initialization procedure for the Data Link Layer shall be completed (e.g., in terms of the OSI connection-mode Data Link Service, this is the establishment of a Data Link connection). Then the DTE shall initiate the restart procedure.

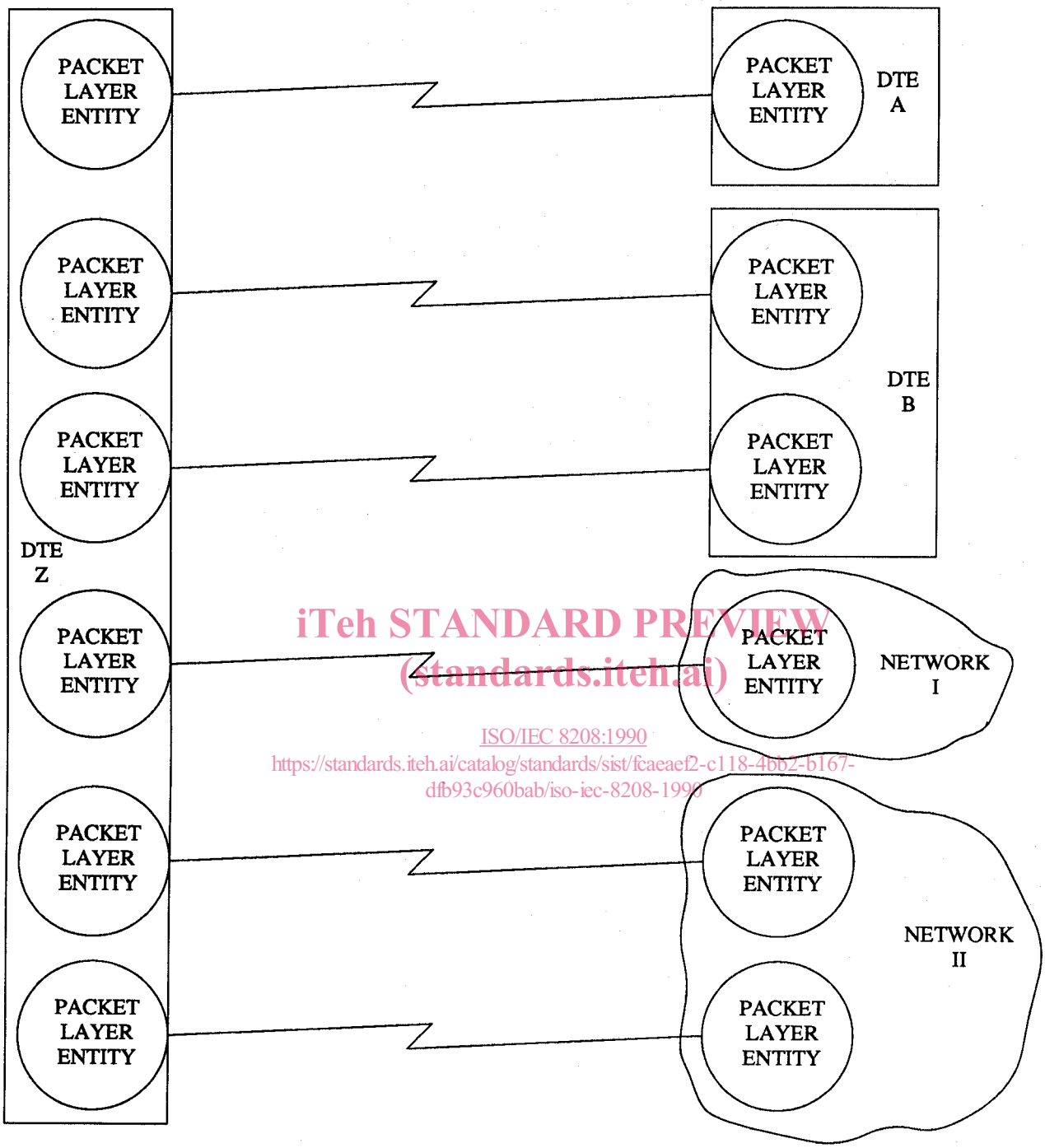


Figure 2 — Packet Layer Entities

Table 1 — Packet Groupings/Functions

Packet Group	Function	Packet Types	Service:* VC	PVC
Call Setup and Call Clearing	Establish and terminate a Virtual Call for DTE/DXE communication; may convey data for higher layer entity processing	CALL REQUEST INCOMING CALL CALL ACCEPTED CALL CONNECTED CLEAR REQUEST CLEAR INDICATION CLEAR CONFIRMATION	X X X X X X X	
Data and Interrupt	Convey data or interrupt information for higher layer entity processing	DATA INTERRUPT INTERRUPT CONFIRMATION	X X X	X X X
Flow Control and Reset	Control the flow of DATA packets across a DTE/DXE interface	RECEIVE READY RECEIVE NOT READY REJECT RESET REQUEST RESET INDICATION RESET CONFIRMATION	X X X X X X	X X X X X X
Restart	(Re)Initialize all communication between a DTE and a DXE	RESTART REQUEST RESTART INDICATION RESTART CONFIRMATION	X X X	X X X
Diagnostic	Pass error diagnostics to a DTE	DIAGNOSTIC	X	X
Registration	Perform registration procedure	REGISTRATION REQUEST REGISTRATION CONFIRMATION	X X	X X

*VC = Virtual Call
PVC = Permanent Virtual Circuit

See also:

— Restart procedures (clause 4).

4 Procedures for restart

The restart procedure is used to initialize or reinitialize the Packet Layer DTE/DXE interface. The restart procedure simultaneously *clears all the Virtual Calls and resets all the Permanent Virtual Circuits* at the DTE/DXE interface (i.e., all the logical channels in a Packet Layer entity). *At the same time, it may also be used to determine how a DTE will subsequently select logical channels for Virtual Calls and how it resolves Virtual Call collisions (see 4.5).*

Figure 3 gives the schematic view of the restart procedure.

There are three states of a logical channel in relation to the restart procedure. As shown in figure 31, they are the PACKET LAYER READY (r1), DTE RESTART REQUEST (r2), and DXE RESTART INDICATION (r3) states. When entering state r1, *each Virtual Call logical channel is in the READY state (p1), whereas each Permanent Virtual Circuit logical channel is in the FLOW CONTROL READY state (d1)* (note that these states are contained within the PACKET LAYER READY state (r1)).

Table 32 specifies the actions taken by the DTE on the receipt of packets from the DXE as applied to the restart procedure.

4.1 Originating a restart request

A DTE indicates a restart request at any time by transmitting across the DTE/DXE interface a RESTART REQUEST packet and by starting the Restart Request Response Timer (T20). The interface for each logical channel is then in the DTE RESTART REQUEST state (r2). In this state, all packets except RESTART CONFIRMATION, RESTART INDICA-