

Implementation of
ISO/IEC 8208:1995

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

Committees responsible for this British Standard

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National foreword

This British Standard reproduces verbatim ISO/IEC 8208:1995 and implements it as the UK national standard. It supersedes BS ISO/IEC 8208:1990 which is withdrawn.

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- aid enquirers to understand the text;
- present to the responsible international committee any enquiries on interpretation, or proposals for change, and keep UK interests informed;
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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the ISO/IEC title page, pages ii to viii, pages 1 to 207 and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

**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*



Reference number
ISO/IEC 8208:1995(E)

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. 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 voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

International Standard ISO/IEC 8208 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 6, *Telecommunications and information exchange between systems*.

This third edition cancels and replaces the second edition (ISO/IEC 8208:1990), which has been technically revised. It also incorporates amendment 1:1990, amendment 3:1991 and technical corrigendum 1:1992.

Annex A and Annex B form an integral part of this International Standard. Annex C and Annex D are for information only.

1 Scope

This International Standard specifies the procedures, formats and facilities at the Packet Layer for Data Terminal Equipment (DTE) operating in conformance with ITU-T 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, ITU-T Rec. X.200 | ISO/IEC 7498-1.

This International Standard covers DTE operation at the Packet Layer when accessing a public or private packet-switched network conforming to ITU-T 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 ITU-T 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).

To evaluate conformance of a particular implementation, it is necessary to have a statement of which capabilities and options have been implemented. Such a statement is called a Protocol Implementation Conformance Statement (PICS), as defined in ITU-T Rec. X.290 | ISO/IEC 9646-1. Annex B provides the PICS proforma in accordance with the relevant guidance given in ITU-T Rec. X.296 | ISO/IEC 9646-7.

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. The second edition was based on the 1988 CCITT Blue Book text of Recommendation X.25. This third edition is based upon the 1993 version of X.25. Retained within this third edition are the necessary provisions for compatibility with the 1988, 1984 and 1980 versions of X.25. The differences between the first, second and third editions of this International Standard are summarized in Annex C.

It should be noted that this International Standard and ITU-T Recommendation X.25 as it applies to DTEs are different in scope. This International Standard contains the specifications that ITU-T 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 Telecommunication Standardization Bureau of the ITU maintains a register of currently valid ITU-T Recommendations.

2.1 Identical Recommendations | International Standards

ITU-T Recommendation X.200 (1994) | ISO/IEC 7498-1:1994, *Information technology — Open Systems Interconnection — Basic Reference Model: The Basic Model*.

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

ITU-T Recommendation X.273 (1994) | ISO/IEC 11577:1995, *Information technology — Open Systems Interconnection — Network layer security protocol*.

CCITT Recommendation X.612 (1992) | ISO/IEC 9574:1992, *Information technology — Provision of the OSI connection-mode network service by packet-mode terminal equipment connected to an integrated services digital network (ISDN)*.

CCITT Recommendation X.613 (1992) | ISO/IEC 10588:1993, *Information technology — Use of X.25 Packet Layer Protocol in conjunction with X.21/X.21 bis to provide the OSI connectionmode Network Service*.

CCITT Recommendation X.614 (1992) | ISO/IEC 10732:1993, *Information technology — Use of X.25 Packet Layer Protocol to provide the OSI connection-mode Network Service over the telephone network.*

2.2 Paired Recommendations | International Standards equivalent in technical content

— CCITT Recommendation T.50 (1992), *International Reference Alphabet (IRA).*

ISO/IEC 646:1991, *Information technology — ISO 7-bit coded character set for information interchange.*

— CCITT Recommendation X.212 (1988), *Data link service definition for open systems interconnection for CCITT applications.*

ISO/IEC 8886:1992, *Information technology — Telecommunications and information exchange between systems — Data link service definition for Open Systems Interconnection.*

— ITU-T Recommendation X.223 (1993), *Use of X.25 to provide the OSI connection-mode network service for ITU-T applications.*

ISO/IEC 8878:1992, *Information technology — Telecommunications and information exchange between systems — Use of X.25 to provide the OSI Connection-mode Network Service.*

— ITU-T Recommendation X.290 (1995), *OSI conformance testing methodology and framework for protocol Recommendations for ITU-T applications — General concepts.*

ISO/IEC 9646-1:1995, *Information technology — Open Systems Interconnection — Conformance testing methodology and framework — Part 1: General concepts.*

— ITU-T Recommendation X.296 (1995), *OSI conformance testing methodology and framework for protocol Recommendations for ITU-T applications — Implementation Conformance Statements.*

ISO/IEC 9646-7:1995, *Information technology — Open Systems Interconnection — Conformance testing methodology and framework — Part 7: Implementation Conformance Statements.*

2.3 Additional references

CCITT Recommendation D.12 (1988), *Measurement unit for charging by volume in the international packet-switched data communication service.*

ITU-T Recommendation X.2 (1993), *International data transmission services and optional user facilities in public data networks and ISDNs.*

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.*

ITU-T Recommendation X.29 (1993), *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.*

ITU-T Recommendation X.31 (1993), *Support of packet mode terminal equipment by an ISDN.*

ITU-T Recommendation X.32 (1993), *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.*

ITU-T Recommendation X.96 (1993), *Call progress signals in public data networks.*

ITU-T Recommendation X.121 (1993), *International numbering plan for public data networks.*

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

CCITT Recommendation X.610 (1992), *Provision and support of the OSI connection-mode network service.*

ISO/IEC 7776:1994, *Information technology — Telecommunications and information exchange between systems — High-level data link control procedures — Description of the X.25 LAPB-compatible DTE data link procedures.*

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

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

ISO/IEC 10039:1991, *Information technology — Open Systems Interconnection — Local area networks — Medium Access Control (MAC) service definition.*

ISO/IEC TR 13532:—, *Information technology — Telecommunications and information exchange between systems — Protocol combinations to provide and support the OSI network service*¹⁾.

RFC 1166, *Internet numbers*, July 1990.

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.²⁾ 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 the Data Link Layer 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);
- i) conformance requirements (clause 21);
- j) 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 (Annex A); and
- k) the PICS proforma (Annex B).

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 ITU-T X-series recommendations.
- e) abbreviations are listed in Annex D.

The Packet Layer procedures in this International Standard are based on an underlying service (for example, that provided by ISO/IEC 7776 or, more generally, the provision of the OSI Data Link Service defined in CCITT Rec. X.212|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.

¹⁾ To be published.

²⁾ 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.

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 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) generally follow the organization of text in Recommendation X.25.

3.1 Compatibility with versions of Recommendation X.25

The Packet Layer procedures and formats specified in this International Standard are compatible with the 1993 version of Recommendation X.25.

NOTE The TOA/NPI Address Subscription Facility along with associated addressing procedures and formats, introduced into the 1988 version and further elaborated in the 1993 version of Recommendation X.25, is not included in this International Standard since the ITU-T has continued its designation 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.25-1988

For DTEs needing to operate with the 1988 (Blue Book) version of Recommendation X.25, the following 1993 capabilities are not used:

- a) *expanded format of the Address Fields; for 1988 operation, only the Address Block with the A-bit = 0 is permitted (see 12.2);*
- b) *Facility Fields in CALL REQUEST, INCOMING CALL, CALL ACCEPTED, CALL CONNECTED, CLEAR REQUEST, CLEAR INDICATION, and CLEAR CONFIRMATION, packets with a length from 109 to 255 octets (see 12.2.2, 12.2.3.1, 12.2.4.1, 12.2.5.2 and 12.2.6.2); for 1988 operation, this field is limited to 109 octets.*
- c) *the following optional user facilities*
 - *Alternative Addressing related facilities (see 13.28);**for 1988 operation, these facilities were not defined;*
- d) *expanded capabilities for the following optional user facilities*
 - *Throughput Class Negotiation facilities (see 13.13), and*
 - *Call Redirection and Call Deflection related facilities (see 13.25);**for 1988 operation, the Extended Throughput Class Negotiation Facility and the Inter-network Call Redirection and Deflection (ICRD) control facilities were not defined;*
- e) *coding of the following CCITT-specified DTE facilities (renamed “ITU-T specified DTE facilities” in the 1993 version of Recommendation X.25) were modified*
 - *Minimum Throughput Class Negotiation (see 15.3.2.3);**for 1988 operation, only the basic format existed; and*

f) the throughput classes of 128 000 bit/s and 192 000 bit/s (in the basic format) and throughput classes from 256 000 bit/s up to, and including, 2 048 000 bit/s (in the extended format); for 1988 operation, the largest throughput class is 64 000 bit/s.

It should also be noted that the term “RPOA” meaning Recognized Private Operating Agency used in 1988 and earlier versions of Recommendation X.25 has been replaced by the term “ROA” meaning Recognized Operating Agency in the 1993 version of Recommendation X.25.

3.1.2 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 in addition to those cited in 3.1.1:

- 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*

- *Calling Address Extension (see 15.3.2.1), and*
- *Called Address Extension (see 15.3.2.2);*

for 1984 operation, only BCD encoding of the addresses is permitted; and

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

3.1.3 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 3.1.2:

- 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 12.2.3.1 and 12.2.4.1); 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 12.2.5.1.1, 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 12.2.5.2); 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 12.2.6.2); 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**.

NOTE 1 The situation where the “DTE” is a private network accessing a public network DCE is covered in Annex A.

NOTE 2 The DCE may be a packet-switched data network operating in accordance with Recommendation X.25 or a packet handler capability in an ISDN operating in accordance with 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 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 1 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).*

NOTE This does not apply if the Reference Number Facility is used.

(The 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 one of the Throughput Class Negotiation facilities (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 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 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/IEC TR 13532 and CCITT Recommendation X.610). The Packet Layer protocol supports all the elements of the OSI connection-mode Network Service specified in CCITT Rec. X.213 | ISO/IEC 8348. Mappings to/from the Packet Layer protocol elements and the primitives and parameters of the connection-mode Network Service are described in ITU-T Recommendation X.223 and ISO/IEC 8878. Additional provisions applicable in an ISDN environment are described in CCITT Rec. X.612 | ISO/IEC 9574.

Additional provisions applicable to a circuit-switched data network environment are described in CCITT Rec. X.613 | ISO/IEC 10588. Additional provisions applicable to the telephone network environment are described in CCITT Rec. X.614 | ISO/IEC 10732

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.

3.7.1 Normal mechanism for Logical Channel Identifier assignment

Each Virtual Call and Permanent Virtual Circuit is assigned a Logical Channel Identifier,³⁾ 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.

3.7.2 Alternative mechanism for Logical Channel Identifier assignment

This alternative mechanism for Logical Channel Identifier assignment only applies in a DTE/DTE environment.

An alternative mechanism for Logical Channel Identifier assignment, which may be used in DTE/DTE environment only, is provided by the Reference Number Optional User Facility. When this mechanism is used, Figure 1 does not apply. Instead, one logical channel exists for each Logical Channel Identifier value in the range 1 to 4 095, but only a limited number of values — as determined by the DTE — need be assigned at any given time to Permanent Virtual Circuits and to Virtual Calls established or in the process of being established.

NOTE 1 Under the normal mechanism for Logical Channel Identifier assignment, the assigned logical channel number of a Virtual Call or a Permanent Virtual Circuit is the same in both directions of transmission at an interface. However, the alternative mechanism for Logical Channel Identifier assignment for a Virtual Call or a Permanent Circuit can assign a different number for each direction of transmission at an interface.

NOTE 2 The alternative mechanism, by allowing a DTE to choose the logical channel identifier values that can appear in received packets, can ease the task of managing logical channels where a DTE can be involved in simultaneous operation over multiple DTE/DTE interfaces, a situation typical in LAN environment (e.g., in Figure 2, DTE Z in its communication with DTEs A and B).

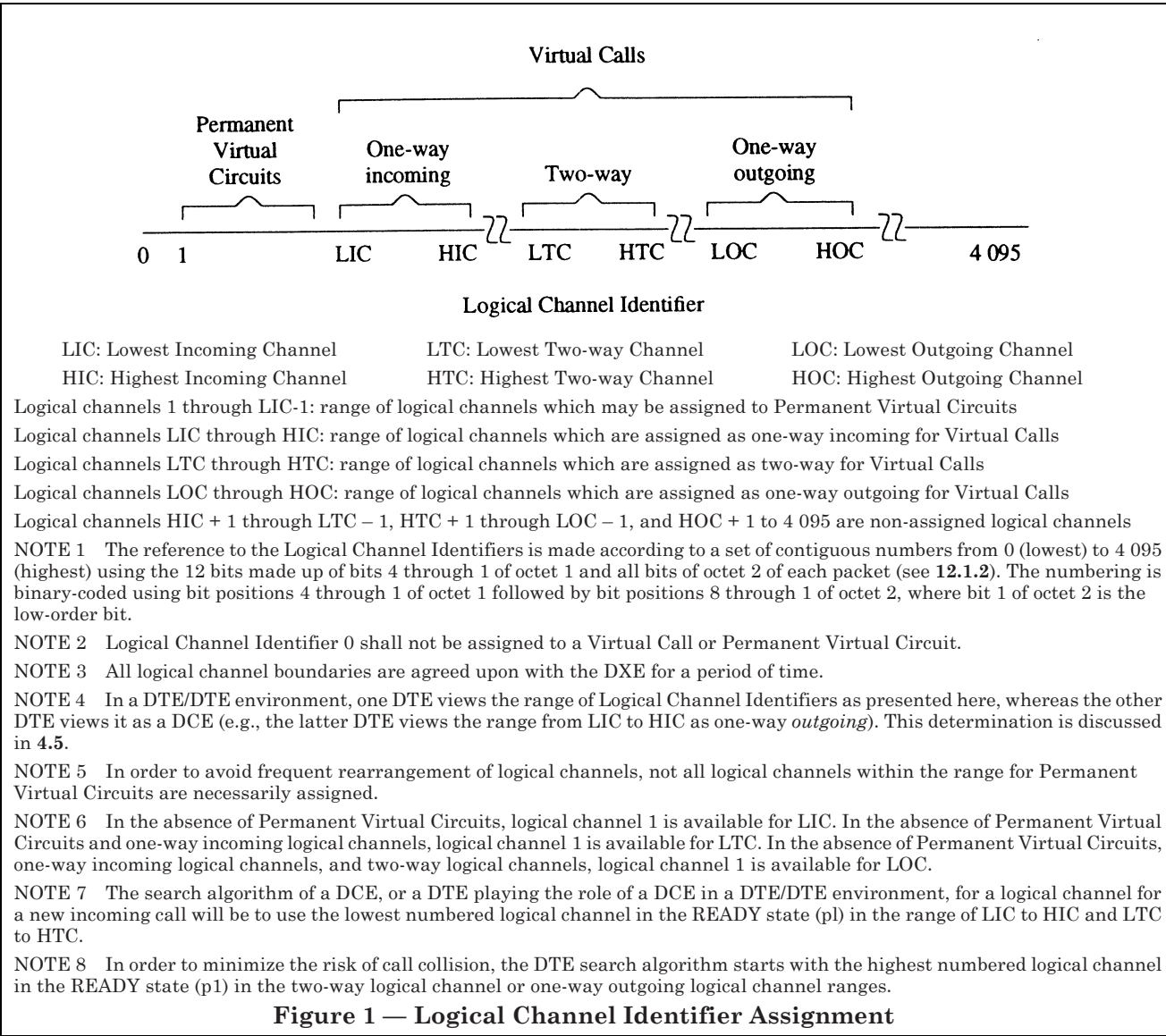
See also:

- Optional User Facility for Reference Number (13.29).

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

³⁾ 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 multiple logical channel DTE/DXE interface, a range of logical channels will be agreed to according to the following diagram:



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 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.

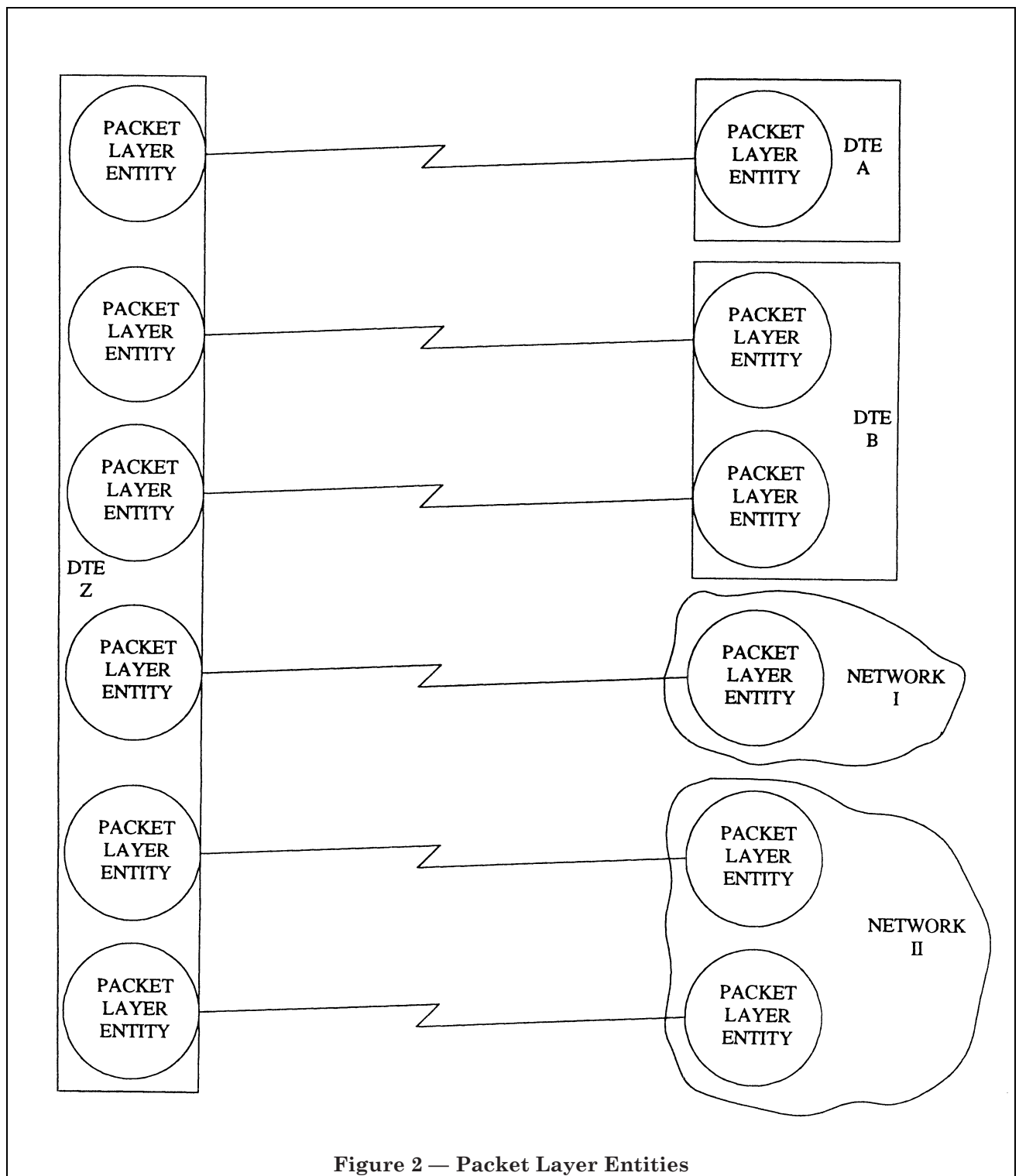


Table 1 — Packet Groupings/Functions

Packet Group	Function	Packet Types	Service: ^a	
			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

^a 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).*

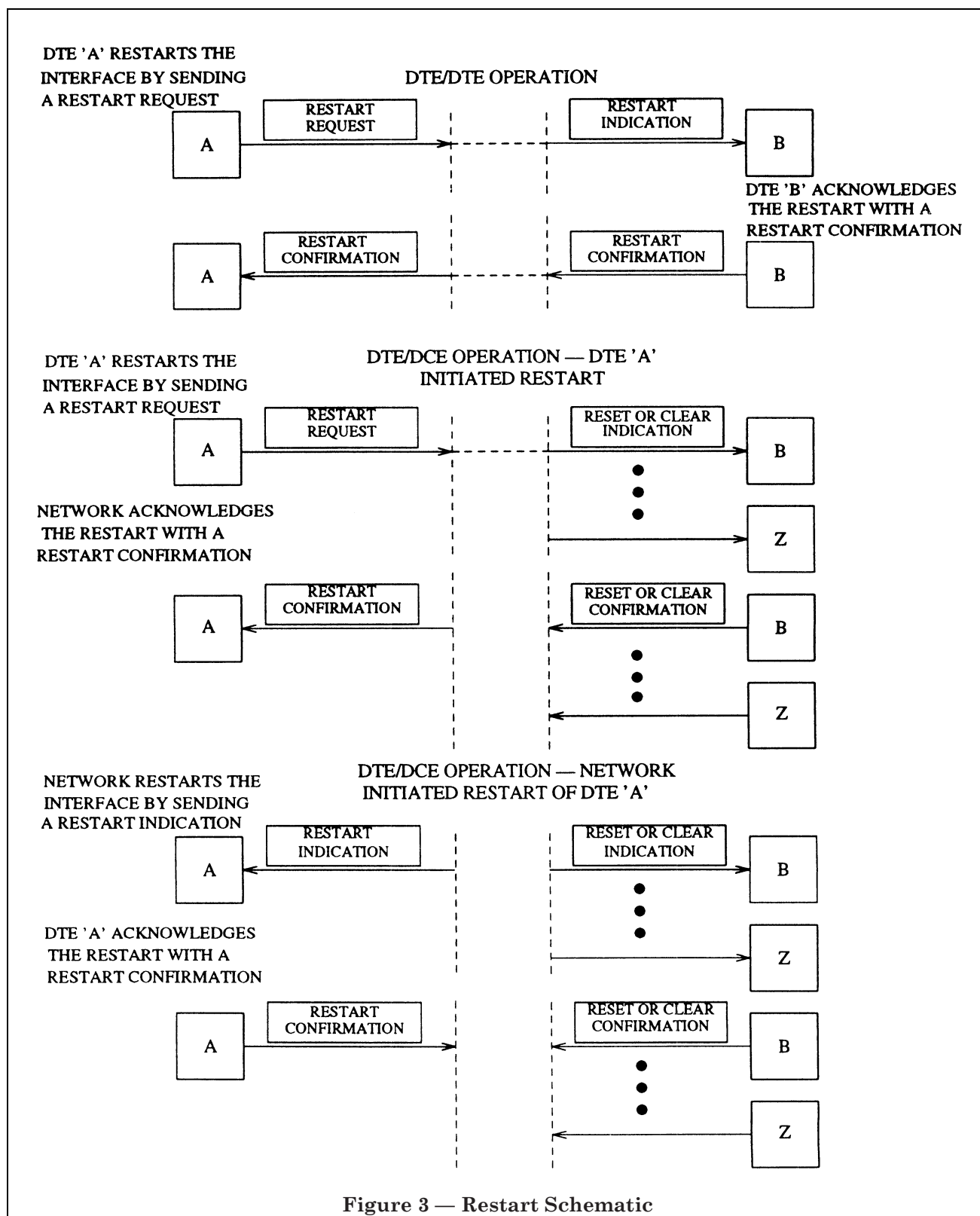
Figure 3 gives the schematic view of the restart procedure.

There are three states of a logical channel in relation to the restart procedure. As shown in Figure 34, 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 INDICATION, *REGISTRATION REQUEST (DTE/DTE environment only)*, REGISTRATION CONFIRMATION, and DIAGNOSTIC packets are ignored. Therefore, higher layer entities must be able to cope with the various possible situations that may occur.



The failure to receive a RESTART CONFIRMATION packet or a RESTART INDICATION packet before expiration of T20 after transmission of a RESTART REQUEST packet is considered an error. The restart procedure is retried up to a maximum number of times R20. After this, the Packet Layer notifies the appropriate entity that it has not received a confirmation of the restart procedure. Each logical channel then remains in the DTE RESTART REQUEST state (r2).

See also:

- RESTART REQUEST packet format (12.6.1 and Figure 24);
- Restart Request Response Timer (T20) (Table 26);
- Restart Request Retransmission Count (R20) (Table 27);
- Receiving a restart indication (4.2);
- Restart collision (4.3);
- Restart confirmation (4.4);
- Packet Layer initialization and reinitialization (3.10 and clause 10).

4.2 Receiving a restart indication

Upon receipt of a RESTART INDICATION packet by a DTE, the interface for each logical channel is in the DXE RESTART INDICATION state (r3). In this state, a DTE considers subsequent receipt of any packet, other than another RESTART INDICATION, *REGISTRATION REQUEST (DTE/DTE environment only)*, REGISTRATION CONFIRMATION, and DIAGNOSTIC packets as an error. It discards any such packet and transmits a RESTART REQUEST packet with a cause indicating “DTE Originated” and the diagnostic “Packet Type Invalid For State r3.”

The RESTART INDICATION packet specifies the reason for the restart. The restarting cause code, as well as the diagnostic code and an indication that a restarting procedure has taken place, is passed to a higher layer entity.

NOTE *In a DTE/DTE environment, the RESTART INDICATION packet received by a DTE is the same as the RESTART REQUEST packet transmitted by the other DTE.*

After processing the RESTART INDICATION packet, the DTE transmits a RESTART CONFIRMATION packet across the DTE/DXE interface.

See also:

- RESTART INDICATION packet format (12.6.1 and Figure 24);
- Restarting cause (12.6.1);
- Restart collision (4.3);
- Restart confirmation (4.4);
- Timers to consider when receiving a RESTART INDICATION packet (Table 28).

4.3 Restart collision

Restart collision occurs when a DTE transmits a RESTART REQUEST packet (as described in 4.1) and then receives a RESTART INDICATION packet (as described in 4.2). In this case, a DTE does not transmit nor expect to receive a RESTART CONFIRMATION packet and considers that the restart is completed. However, if the procedures in 4.5 are used, then the DTE shall determine whether the Restarting Cause Field in the RESTART INDICATION packet indicates “DTE Originated.” If so, then the DTE shall take no other action except to transmit another RESTART REQUEST packet after some randomly-chosen time delay. If this field does not indicate “DTE Originated,” then the restart procedure is completed.

When the restarting procedure is completed, each *Virtual Call logical channel is in the READY state (p1) whereas each Permanent Virtual Circuit logical channel is in the FLOW CONTROL READY state (d1).*

4.4 Restart confirmation

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

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

When the restarting procedure is completed, each *Virtual Call logical channel is in the READY state (p1) whereas each Permanent Virtual Circuit logical channel is in the FLOW CONTROL READY state (d1).*

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

See also:

- RESTART CONFIRMATION packet format (12.6.2 and Figure 25).

4.5 Determining “DTE” or “DCE” characteristics

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

When prepared to initialize the Packet Layer, the DTE shall initiate the restart procedure (i.e., transmit a RESTART REQUEST packet). The determination is based on the response received from the DXE, as outlined below.

- a) If the DTE receives a RESTART INDICATION packet with a restarting cause code that is not “DTE Originated” (i.e., it came from a DCE), then the DTE shall follow the procedures in 4.2, 4.3, and 4.4 as appropriate and maintain its role as a DTE.
- b) If the DTE receives a RESTART INDICATION packet with a restarting cause code of “DTE Originated” (i.e., it came from another DTE) and it does not have an unconfirmed RESTART REQUEST packet outstanding (i.e., no restart collision), then the DTE shall confirm the restart (as in 4.4) and act as a DCE.
- c) If the DTE receives a RESTART INDICATION packet with a restarting cause code of “DTE Originated” (i.e., it came from another DTE) and it does have an unconfirmed RESTART REQUEST packet outstanding (i.e., a restart collision), then the DTE shall consider this restart procedure completed (as in 4.3) but shall take no other action except to transmit another RESTART REQUEST packet after some randomly-chosen time delay.
- d) If the DTE issues a RESTART REQUEST packet that is subsequently confirmed with a RESTART CONFIRMATION packet (as in 4.4), then the DTE shall maintain its role as a DTE.

NOTE 1 If a DTE operates only in a DTE/DCE environment or a DTE/DTE environment where, by administration, the roles can be predetermined and fixed, then the procedures described above are not needed. In these cases, the DTE may be initialized to act in the appropriate manner.

NOTE 2 If a DTE uses the alternative Logical Channel Identifier mechanism (Reference Number Facility) in a DTE/DTE environment, then the procedures described above are not needed.

See also:

- Logical channel selection (Figure 1);
- Virtual Call collision (5.2.5);
- Originating a restart request (4.1);
- Receiving a restart indication (4.2);
- Restart collision (4.3);
- Restart confirmation (4.4);
- Restarting cause (12.6.1);
- Optional User Facility for Reference Number (13.29).

5 Procedures for Virtual Call setup and clearing

This clause describes the setup and clearing procedures for Virtual Calls. It applies independently to each logical channel assigned to Virtual Call service at a DTE/DXE interface. (There are no setup and clearing procedures for Permanent Virtual Circuits.) The procedures for selecting a logical channel can be as described here or as described for the Reference Number Facility.

Figure 4 and Figure 5 give a schematic view of how a Virtual Call is set up and cleared, respectively. This information is also shown in the state diagram of Figure 35. Table 33 specifies actions taken by the DTE on the receipt of packets from the DXE as applied to the Virtual Call setup and clearing procedures.

See also:

- Optional User Facility for Reference Number (13.29).

5.1 Ready state

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

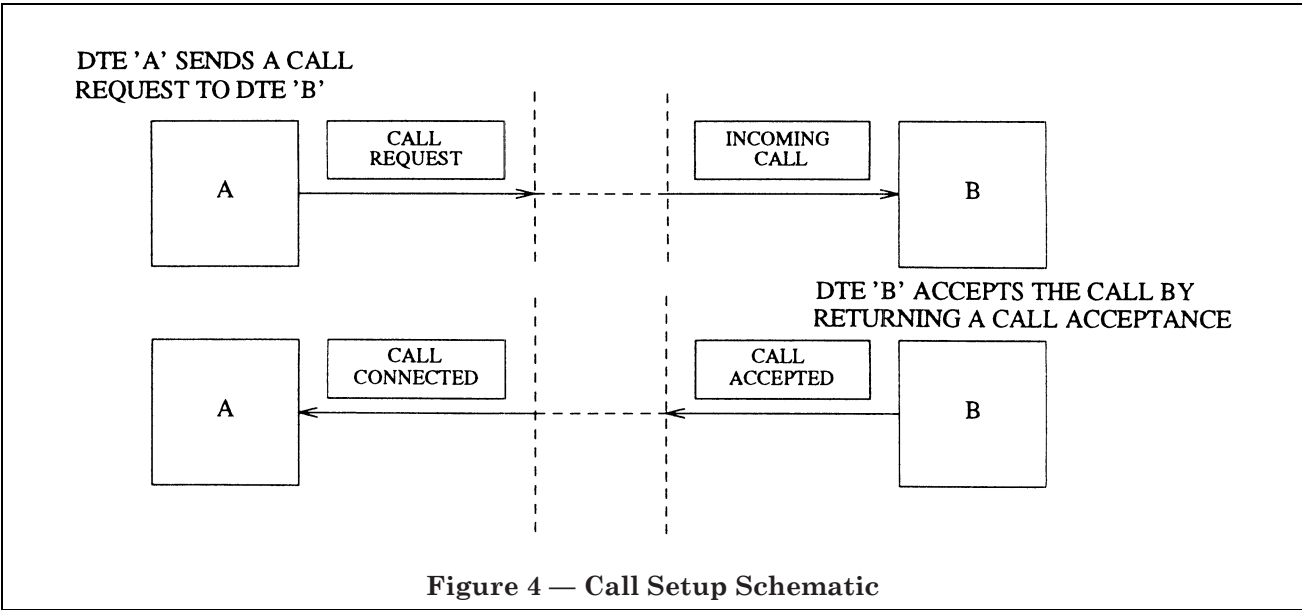
5.2 Procedures for Virtual Call setup

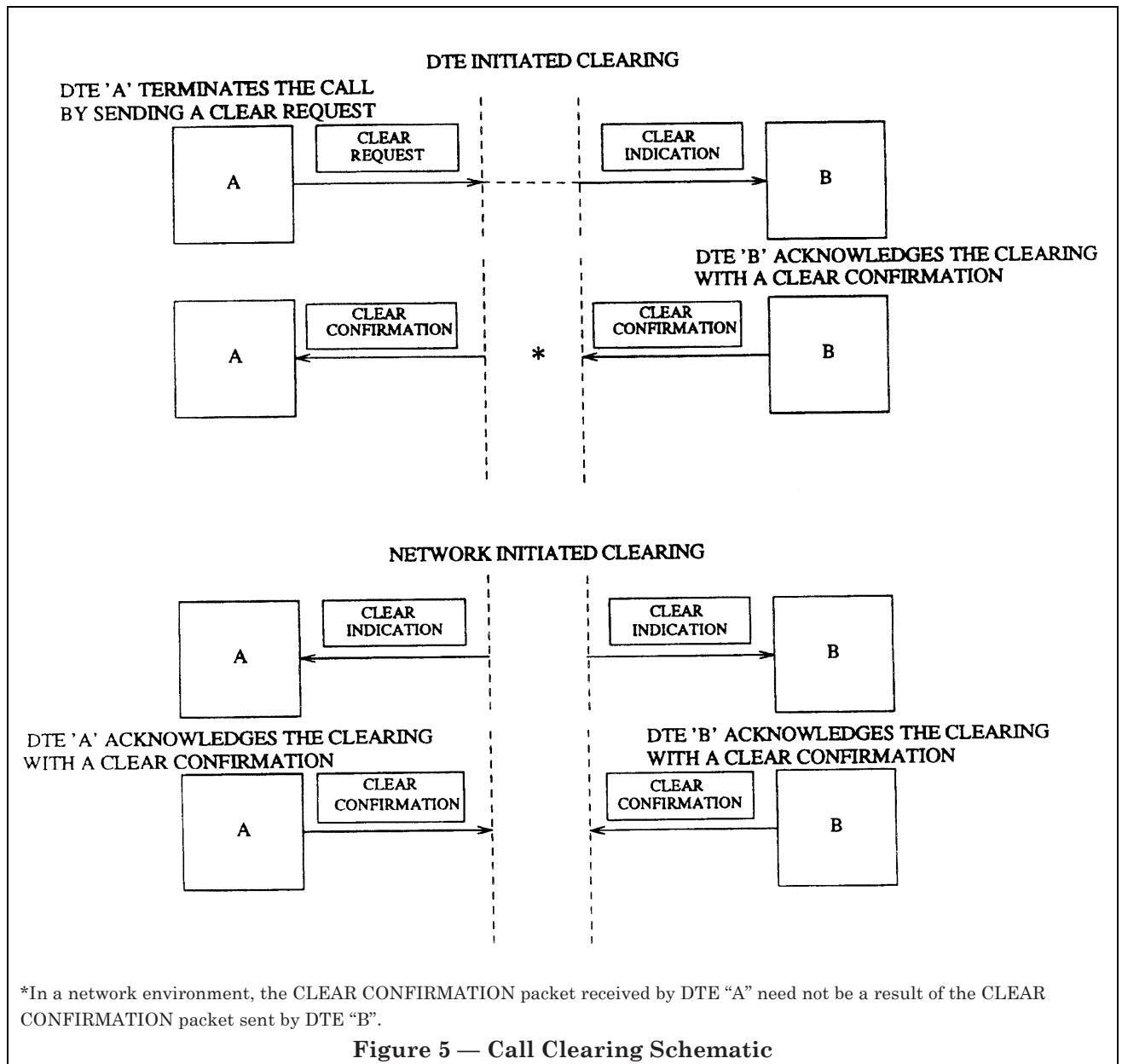
5.2.1 Originating a Virtual Call

A DTE indicates a call request by transmitting across the DTE/DXE interface a CALL REQUEST packet and by starting the Call Request Response Timer (T21). The logical channel selected by the DTE is then in the DTE CALL REQUEST state (p2).

The CALL REQUEST packet may include the called-DTE address and the calling-DTE address. Each address is a sequence of up to 15 digits. This packet may also include any user data supplied by a higher layer entity to be sent to the remote DTE.

NOTE 1 The inclusion of the called-DTE address and the calling-DTE address in the CALL REQUEST packet is dependent upon the requirements of the interfacing DXE.





NOTE 2 A DTE address may be a DTE network address or any other DTE identification agreed to for a period of time between the DTE and the DXE.

NOTE 3 Procedures for determining how a DTE chooses a logical channel in the READY state (p1) when originating a Virtual Call are given in 4.5 and Figure 1. If the DTE maintains its role as a DTE, then it chooses a logical channel starting at the high end of the range of logical channels agreed to with the DXE. *In a DTE/DTE environment, however, if the DTE acts as a DCE for these procedures, then it chooses a logical channel in the READY state (p1) starting at the low end of the range of logical channels.* In this way, the risk of call collision is minimized.

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

See also:

- Call collision (5.2.5);
- Aborting a call request (5.4);
- Call Request Response Timer (T21) (Table 26);
- CALL REQUEST packet format (12.2.3 and Figure 13);

- Clearing procedures (5.5);
- Call setup procedures for use of the D-bit (6.3);
- Logical channel selection (Figure 1);

5.2.2 Receiving an indication of an incoming call

A DTE receives an indication of an incoming call upon receipt of an INCOMING CALL packet from a DXE. The logical channel is then in the DXE INCOMING CALL state (p3).

The INCOMING CALL packet may include the calling-DTE address and the called-DTE address. The address information and any data received as part of this packet is forwarded to a higher layer entity. In addition, optional user facility information may also be passed to a higher layer entity.

NOTE 1 The inclusion of the calling-DTE address and the called-DTE address in the INCOMING CALL packet is dependent upon the operation of the interfacing DXE.

NOTE 2 A DTE address may be a DTE network address or any other DTE identification agreed to for a period of time between the DTE and the DXE.

NOTE 3 In a DTE/DTE environment, the INCOMING CALL packet received by a DTE is the same as the CALL REQUEST packet transmitted by the other DTE.

See also:

- INCOMING CALL packet format (12.2.3 and Figure 13);
- Call collision (5.2.5);
- Accepting an incoming call (5.2.3);
- Rejecting an incoming call (5.3);
- Call setup procedures for use of the D-bit (6.3);
- Timers to consider when receiving an INCOMING CALL packet (Table 28).

5.2.3 Accepting a Virtual Call

A DTE receiving an INCOMING CALL packet indicates its acceptance of the call by transmitting across the DTE/DXE interface a CALL ACCEPTED packet. This packet shall specify the same logical channel as that of the INCOMING CALL packet.

The specified logical channel is then in the FLOW CONTROL READY state (d1).

The decision of whether to accept a call is made by a higher layer entity before a CALL ACCEPTED packet may be returned by the Packet Layer. Furthermore, it may provide data to be returned to the calling DTE as part of the CALL ACCEPTED packet. Data may be returned only if the INCOMING CALL packet indicates the Fast Select Facility without a restriction on the response. A CALL ACCEPTED packet shall not be returned if the INCOMING CALL packet indicates the Fast Select Facility with a restriction on the response.

A call may be rejected, without informing a higher layer entity of its receipt, for reasons local to the Packet Layer (for example, a format error in the INCOMING CALL packet).

See also:

- CALL ACCEPTED packet format (12.2.4 and Figure 14);
- Call setup procedures for use of the D-bit (6.3);
- Rejecting an incoming call (5.3);
- Optional User Facility for Fast Select (13.16).

5.2.4 Receiving a call acceptance indication

The receipt, by the calling DTE, of a CALL CONNECTED packet specifying the same logical channel as that specified in the CALL REQUEST packet indicates that the call has been accepted by the called DTE. The specified logical channel is then in the FLOW CONTROL READY state (d1).

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

NOTE In a DTE/DTE environment, the CALL CONNECTED packet received by a DTE is the same as the CALL ACCEPTED packet transmitted by the other DTE.

See also:

- Nonacknowledgement of a call request (5.4);

- CALL CONNECTED packet format (12.2.4 and Figure 14);
- Call setup procedures for use of the D-bit (6.3).

5.2.5 Call collision

Call collision occurs when a DTE transmits a CALL REQUEST packet (as described in 5.2.1) and then receives an INCOMING CALL packet (as described in 5.2.2) for the same logical channel. At this time, the logical channel is in the CALL COLLISION state (p5). Further action is dependent on whether the DTE maintains its role as a DTE or acts as a DCE for resolving call collision (as determined by the procedures in 4.5).

- If the DTE maintains its role as a DTE, then it shall ignore the INCOMING CALL packet and wait for the response from the DXE. The DTE should receive either a CALL CONNECTED packet (if the call is accepted by the remote DTE) or a CLEAR INDICATION packet for the same logical channel as that in the CALL REQUEST packet.
- *In a DTE/DTE environment, if the DTE acts as a DCE, then it shall cancel its call request and decide whether to transmit a CALL ACCEPTED packet or a CLEAR REQUEST packet.*

NOTE When using the alternative Logical Channel Identifier assignment mechanism (Reference Number Facility), this subclause does not apply.

5.3 Rejecting a call

The previous subclauses described the procedures for accepting a Virtual Call. However, for a variety of reasons, a Virtual Call might not be accepted. For example, these can include:

- a) rejection by the network because the call cannot be completed to the addressed DTE;
- b) rejection by the network or the called DTE because of congestion;
- c) rejection by the network or the called DTE because of a format error in the packet;
- d) rejection by the network or the called DTE of some of the optional user facilities requested by the calling DTE; or
- e) rejection by the called DTE initiated by a higher layer entity.

In any case, the DTE or DCE clears the call by transmitting the appropriate packet to the calling DTE. In those cases where an incoming call is rejected, a CALL ACCEPTED packet (as described in 5.2.3) is not transmitted.

See also:

- Clearing procedures (5.5).

5.4 Aborting a call request

The calling DTE may abort a call by clearing it before it has received a CALL CONNECTED or CLEAR INDICATION packet. This may be due to an abort initiated by a higher layer entity or the expiration of timer T21.

As noted previously, timer T21 is set by a DTE when it initiates a call request. Expiration of this timer (before receipt of an acceptance or a rejection for the call request) is considered a procedure error and results in the DTE clearing the call with a cause indicating "DTE Originated" and the diagnostic "Timer Expired For Call Request."

See also:

- Call Request Response Timer (T21) (Table 26);
- Clearing procedures (5.5).

5.5 Procedures for Virtual Call clearing

A call or call request may be cleared by any party at any time. This may be done at call setup, for example, by the called DTE for the reasons cited in 5.3 or by the calling DTE for the reasons cited in 5.4. Either the called or calling DTE may terminate the Virtual Call either normally because of call completion or abnormally because of error detection.

5.5.1 Originating a Virtual Call clearing

A DTE indicates clearing of a Virtual Call at any time by transmitting across the DTE/DXE interface a CLEAR REQUEST packet specifying the logical channel and by starting the Clear Request Response Timer (T23). The logical channel is then in the DTE CLEAR REQUEST state (p6). In this state, the only acceptable packets on the logical channel are a CLEAR CONFIRMATION packet and a CLEAR INDICATION packet. Other types of packets on the logical channel are ignored. Therefore, higher layer entities must be able to cope with the various possible situations that may occur.

The failure to receive a CLEAR CONFIRMATION packet before the expiration of T23 is considered an error. The clearing procedure is retried up to a maximum number of times R23. After this, the Packet Layer notifies the appropriate entity that it has not received a confirmation of the clearing procedure. The logical channel then remains in the DTE CLEAR REQUEST state (p6).

The CLEAR REQUEST packet may contain data provided by a higher layer entity to be sent to the remote DTE. This may be done only if the CALL REQUEST and INCOMING CALL packets had indicated the Fast Select Facility. A DTE that aborts its own call after transmitting a CALL REQUEST packet and before receiving a response shall not transmit data in the CLEAR REQUEST packet.

See also:

- CLEAR REQUEST packet format (12.2.5 and Figure 15);
- Clear Request Response Timer (T23) (Table 26);
- Clear Request Retransmission Count (R23) (Table 27);
- Optional User Facility for Fast Select (13.16);
- Receiving a clear indication (5.5.2);
- Clear collision (5.5.3);
- Clear confirmation (5.5.4).

5.5.2 Receiving an indication of Virtual Call clearing

Receipt of a CLEAR INDICATION packet indicates Virtual Call clearing. At this time, the logical channel is the DXE CLEAR INDICATION state (p7). In this state, a DTE considers subsequent receipt of packets on the logical channel, other than another CLEAR INDICATION packet, as an error. It discards any such packet and transmits a CLEAR REQUEST packet with a cause indicating “DTE Originated” and the diagnostic “Packet Type Invalid For State p7.”

The CLEAR INDICATION packet specifies the reason for the clearing. The clearing cause code, as well as the diagnostic code and an indication that a clearing procedure has taken place, is passed to a higher layer entity. Any data and optional user facility information received in the CLEAR INDICATION packet is also forwarded to a higher layer entity.

NOTE In a DTE/DTE environment, the CLEAR INDICATION packet received by a DTE is the same as the CLEAR REQUEST packet transmitted by the other DTE.

After processing the CLEAR INDICATION packet, the DTE transmits a CLEAR CONFIRMATION packet across the DTE/DXE interface.

See also

- CLEAR INDICATION packet format (12.2.5 and Figure 15);
- Clearing cause (12.2.5);
- Clear collision (5.5.3);
- Clear confirmation (5.5.4);
- Timers to consider when receiving a CLEAR INDICATION packet (Table 28).

5.5.3 Clear collision

Clear collision occurs when a DTE transmits a CLEAR REQUEST packet (as described in 5.5.1) and then receives a CLEAR INDICATION packet (as described in 5.5.2) for the same logical channel. In this case, a DTE does not transmit nor expect to receive a CLEAR CONFIRMATION packet and considers that the clearing is completed.

When the clearing procedure is completed, the logical channel is in the READY state (p1).

5.5.4 Clear confirmation

When a DTE is prepared to acknowledge a clear, it transmits a CLEAR CONFIRMATION packet across the DTE/DXE interface. At this time, the clearing procedure is considered completed.

Having initiated a clearing procedure, the DTE considers the clearing procedure completed when it receives a CLEAR CONFIRMATION packet.

When the clearing procedure is completed, the logical channel is in the READY state (p1).

In a network environment, the CLEAR CONFIRMATION packet received from a DCE can only be interpreted universally as having local significance. However, within some networks, clear confirmation may have end-to-end significance.

See also:

- CLEAR CONFIRMATION packet format (12.2.6 and Figure 16).

6 Procedures for data and interrupt transfer

The data and interrupt transfer procedures described in this clause apply independently to each logical channel assigned for Virtual Calls or Permanent Virtual Circuits existing at the DTE/DXE interface.

Normal operation dictates that user data in DATA and INTERRUPT packets are all passed transparently and unaltered, either directly or through a network in the case of packet-DTE to packet-DTE communications. The order of bits in DATA and INTERRUPT packets is preserved. Packet sequences are delivered as complete packet sequences.

See also:

- DATA packet format (12.3.1 and Figure 17);
- INTERRUPT packet format (12.3.2 and Figure 18);
- Complete packet sequences (6.5).

6.1 States for data and interrupt transfer

For purposes of data and interrupt transfer, a logical channel must be in the FLOW CONTROL READY state (d1). *A Virtual Call logical channel is in state d1 after completion of call setup and prior to a clearing, reset, or restart procedure. A Permanent Virtual Circuit logical channel is continually in state d1 except during a reset or restart procedure.*

While in state d1, DATA, interrupt, flow control, reset, and REJECT (if subscribed to) packets may be transmitted across the DTE/DXE interface. While in a state other than d1, the above-mentioned packets may be discarded. Therefore, higher layer entities must be able to cope with the various possible situations that may occur.

See also:

- Restart procedures (clause 4);
- Call setup procedures (5.2);
- Clearing procedures (5.5);
- Flow control procedures (7.1);
- Reset procedures (clause 8);
- Nonreceipt of window-rotation information (11.2);
- Receipt of erroneous DATA packets (11.3);
- Optional User Facility for Packet Retransmission (13.4).

6.2 Maximum User Data Field length of DATA packets

The standard default maximum User Data Field length is 128 octets.

In addition, other (nonstandard) default maximum User Data Field lengths may be available from the following list: 16, 32, 64, 256, 512, 1 024, 2 048, and 4 096 octets.

From the combination of the standard default and the list of nonstandard defaults, if any, a maximum User Data Field length shall be selected for each direction of data transmission. *For Virtual Calls, this choice applies in common to all logical channels at the DTE/DXE interface. For Permanent Virtual Circuits, this choice is made separately for each logical channel.* These selections are agreed to for a period of time with the DXE. *In addition, negotiation of the maximum User Data Field length on a per Virtual Call basis is allowed if the Flow Control Parameter Negotiation Facility has been subscribed to.*

The User Data Field of DATA packets transmitted by a DTE shall contain an integral number of octets (see 12.1).

If the User Data Field in a DATA packet exceeds the locally-permitted maximum User Data Field length or if it is nonoctet aligned, then the receiving DTE shall invoke appropriate error-recovery procedures.

See also:

- Optional User Facility for Nonstandard Default Packet Sizes (13.9);
- Optional User Facility for Flow Control Parameter Negotiation (13.12);
- Receipt of erroneous DATA packets (11.3);

6.3 Delivery Confirmation bit

The setting of the Delivery Confirmation bit (D-bit) is used to indicate whether the DTE wishes to receive an end-to-end acknowledgement of delivery for data it is transmitting. To indicate data for which an end-to-end acknowledgement is desired, the DTE sets the D-bit to 1. Acknowledgement is given by means of the packet receive sequence number P(R). When the D-bit is set to 0, a subsequently-received P(R) has no significance with respect to acknowledgement.

NOTE 1 The use of the D-bit procedure does not obviate the need for a higher layer protocol agreed upon between the communicating DTEs. Such a protocol may be used with or without the D-bit procedure to recover from various error situations.

NOTE 2 The setting of the D-bit is determined from instructions received from a higher layer entity.

The following is an optional mechanism that DTEs can use during Virtual Call establishment to negotiate whether to use the D-bit during the FLOW CONTROL READY state (d1).

If the calling DTE is willing to use the D-bit procedure, then it should set bit 7 in the General Format Identifier of the CALL REQUEST packet to 1; otherwise, it should set this bit to 0. If the called DTE is willing to use the D-bit procedure and receives an INCOMING CALL packet with bit 7 in the General Format Identifier set to 1, then it should set bit 7 in the General Format Identifier of the CALL ACCEPTED packet to 1; otherwise, it should set this bit to 0.

With this procedure, bit 7 in the General Format Identifier set to 1 in the CALL ACCEPTED and CALL CONNECTED packets indicates the D-bit procedure in 7.1.4 applies for the Virtual Call. If bit 7 in the General Format Identifier is set to 0 in the CALL ACCEPTED and CALL CONNECTED packets, then the DTEs should set the D-bit to 0 in all DATA packets.

If the DTE is unwilling to use the D-bit procedure and receives a DATA packet with the D-bit set to 1, then it shall reset the logical channel with a cause indicating “DTE Originated” and the diagnostic “D-bit Procedure Not Supported.”

See also:

- Packet receive sequence number P(R) (7.1.3);
- Delivery confirmation (7.1.4);
- Procedures for Virtual Call setup (5.2);
- Reset procedures (clause 8).

6.4 More Data mark

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

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

A sequence of DATA packets with every M-bit set to 1 except for the last packet will be delivered as a sequence of DATA packets with the M-bit set to 1 except for the last packet when the original packets having the M-bit set to 1 are either full (irrespective of the setting of the D-bit) or partially full but have the D-bit set to 1. Within the scope of this International Standard, such sequences are used to delimit logical messages transmitted between higher layer entities. Such sequences are known as M-bit sequences. Figure 6 illustrates, for an M-bit sequence, the relationship between the D-bit settings, the M-bit settings, and whether the User Data Fields of DATA packets are full.

Two categories of DATA packets, A and B, have been defined as shown in Table 2. *Table 2 also illustrates the network's treatment of the M- and D-bits for a Virtual Call or Permanent Virtual Circuit.* A DTE shall not transmit a partially full DATA packet with the M-bit set to 1 and the D-bit set to 0. Upon receipt of such a packet, the DTE shall reset the logical channel with a cause indicating "DTE Originated" and the diagnostic "Invalid Partially Full DATA Packet."

See also:

- Fragmentation and reassembly of messages (6.7);
- Reset procedures (clause 8).

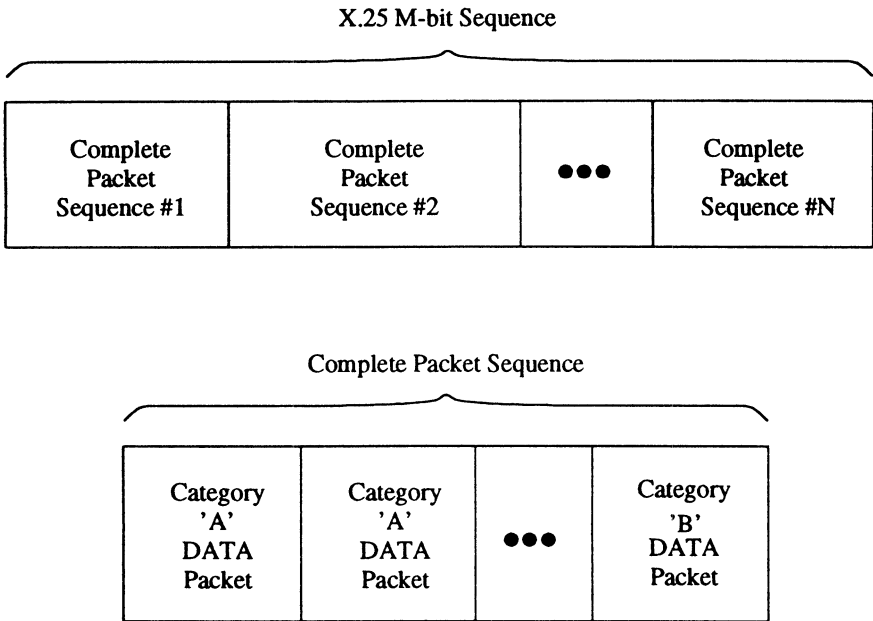
6.5 Complete packet sequence

A complete packet sequence is defined as being composed of a single category B packet and all contiguous preceding category A packets (if any). Category A DATA packets have the exact maximum User Data Field length with the M-bit set to 1 and the D-bit set to 0. All other DATA packets are category B packets. Figure 6 illustrates, for a complete packet sequence, the relationship between the D-bit settings, the M-bit settings, and whether the User Data Fields of DATA packets are full.

When transmitted by a source DTE, a complete packet sequence is always delivered to the destination DTE as a single complete packet sequence. (Note that an M-bit sequence may be comprised of one or more complete packet sequences as defined in this subclause.)

The remainder of this subclause pertains to network operation relative to transmission and delivery of packets in a complete packet sequence.

If the receiving DTE has a larger maximum User Data Field length than the transmitting DTE, then the DATA packets within a complete packet sequence will be combined within the network. They will be delivered in a complete packet sequence where each packet, except the last one, has the exact maximum User Data Field length, the M-bit set to 1, and the D-bit set to 0. The User Data Field of the last packet of the sequence may have less than the maximum length and the M- and D-bits set as described in Table 2.



A Complete Packet Sequence contains zero or more Category “A” DATA packets plus one Category “B” DATA packet

D-bit	M-bit	User Data Field	Remarks
0	1	Full	Category “A” DATA packet
1	1	<Full	Category “B” DATA packet that marks the end of a CPS but not the end of an MBS
1	1	Full	
0	0	<Full	Category “B” DATA packet that simultaneously marks the end of a CPS and an MBS
0	0	Full	
0	1 ^a	<Full	
1	0	<Full	
1	0	Full	

^a A network will change this M-bit to 0; therefore, a DTE shall never originate this Category “B” packet. If a DTE receives this type of packet, then it shall reset the logical channel with a cause indicating “DTE Originated” and the diagnostic “Invalid Partially Full DATA Packet.”

M-bit refers to the MORE DATA bit;
D-bit refers to the DELIVERY CONFIRMATION bit;
CPS refers to a Complete Packet Sequence; and
MBS refers to an M-bit Sequence.

Figure 6 — Packet Sequence Composition

**Table 2 — Definition of Two Categories of Data Packets
and Network Treatment of the M and D Bits**

DATA Packet Received From Source DTE				Combining with Subsequent Packet(s) is Performed by the Network when Possible	DATA Packet Sent To Destination DTE (see Note 1)	
Category	M	D	Full		M	D
B	0 or 1	0	No	No	0 (see Note 2)	0
B	0	1	No	No	0	1
B	1	1	No	No	1	1
B	0	0	Yes	No	0	0
B	0	1	Yes	No	0	1
A	1	0	Yes	Yes (see Note 3)	1	0
B	1	1	Yes	No	1	1

NOTE 1 Refers to the delivered DATA packet whose last bit of user data corresponds to the last bit of user data, if any, that was present in the DATA packet sent by the source DTE.

NOTE 2 The originating network will force the M-bit to 0.

NOTE 3 If the DATA packet sent by the source DTE is combined with other packets, up to and including a category B packet, the M-bit and D-bit settings in the DATA packet received by the destination DTE will be according to that given in the two right-hand columns for the last DATA packet sent by the source DTE that was part of the combination.

If the maximum length of the User Data Field is the same at both DTEs, then User Data Fields of DATA packets are delivered to the receiving DTE exactly as they have been received by the network, except as follows. If a full DATA packet with the M-bit set to 1 and the D-bit set to 0 is followed by an empty DATA packet, then the two packets may be merged so as to become a single category B full packet. If the last packet of a complete packet sequence transmitted by the source DTE has a User Data Field less than the maximum length, the M-bit set to 1 and the D-bit set to 0 (which a DTE is not permitted to send within the scope of this International Standard), then the last packet of the complete packet sequence delivered by the network to the receiving DTE will have the M-bit set to 0.

If the receiving DTE has a smaller maximum User Data Field length than the transmitting DTE, then packets will be segmented within the network. The M- and D-bits will be set by the network as described to maintain complete packet sequences.

See also:

- D-bit (6.3);
- M-bit sequences (6.4 and Figure 6).

6.6 Qualifier bit

In some cases, an indicator may be needed with the User Data Field of DATA packets to distinguish between two types of information carried in the field. It may be necessary to differentiate, for example, between user data and control information. An example of such a case is contained in Recommendation X.29. If such a mechanism is needed, an indicator called the Qualifier bit (Q-bit) may be used.

The use of the Q-bit is optional. If this mechanism is not needed, then the Q-bit is always set to 0. If the Q-bit mechanism is used, then the transmitting DTE shall set the Q-bit in all DATA packets of a complete packet sequence to the same value, either 0 or 1. The setting of the Q-bit in a complete packet sequence is determined from instructions received from a higher layer entity. Likewise, the setting the Q-bit for each complete packet sequence received is passed to a higher layer entity.

A complete packet sequence, which is transmitted with the Q-bit set to the same value in all DATA packets, is delivered as a complete packet sequence with the Q-bit set in all DATA packets to the value assigned by the transmitting DTE.

If the Q-bit is not set by the DTE to the same value in all the DATA packets of a complete packet sequence, the value of the Q-bit in any of the DATA packets or the corresponding complete packet sequence transferred to the distant DTE is not guaranteed by the network. Moreover, some networks may reset the Virtual Call or Permanent Virtual Circuit. If the Q-bit is not set to the same value in all DATA packets in a complete packet sequence, the receiving DTE shall reset the logical channel with a cause indicating "DTE Originated" and the diagnostic "Inconsistent Q-bit Settings."

DATA packets are numbered consecutively regardless of their Q-bit settings.

See also:

- Complete packet sequences (6.5 and Figure 6);
- Numbering of packets (7.1.1);
- Reset procedures (clause 8).

6.7 Fragmentation and reassembly of messages

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

NOTE It is permissible to fragment a message in such a way that results in a DATA packet containing a User Data Field of zero length.

In a receiving DTE, the Packet Layer reassembles the User Data Fields of DATA packets into a message. The message is passed to a higher layer entity with an indication of the length and Q-bit setting of each complete packet sequence, and an indication of whether the higher layer entity must confirm delivery of the message upon receipt.

See also:

- Maximum User Data Field Length of DATA packets (6.2);
- D-bit (6.3);
- M-bit sequences (6.4 and Figure 6);
- Complete packet sequences (6.5 and Figure 6);
- Q-bit (6.6);
- Delivery confirmation (7.1.4).

6.8 Procedures for interrupt

The interrupt procedure allows a DTE to transmit data to a remote DTE without following the flow control procedures applying to DATA packets. This data is contained in an INTERRUPT packet. The initiation of the interrupt procedure and the generation of the data are controlled by a higher layer entity. Upon receipt of an INTERRUPT packet, a signal indicating that an interrupt has occurred, along with the data, is passed to a higher layer entity.

Figure 7 gives a schematic view of the interrupt procedure.

The interrupt procedure can apply only in the FLOW CONTROL READY state (d1). Therefore, the interrupt procedure is abandoned as a result of a *clearing (Virtual Calls only)*, reset, or restart procedure. Within state d1, there are four states (two for each direction of interrupt transmission) that apply to the interrupt procedure. They are the DTE INTERRUPT READY (i1), DTE INTERRUPT SENT (i2), DXE INTERRUPT READY (j1), and DXE INTERRUPT SENT (j2) states, as shown in Figure 37. Table 35 specifies the action taken by the DTE on the receipt of interrupt packets from the DXE as applied to the interrupt procedure.

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

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

6.8.1 Interrupt transmission

Prior to transmitting an interrupt, the logical channel is in the DTE INTERRUPT READY state (i1). To send an interrupt, a DTE transmits across the DTE/DXE interface an INTERRUPT packet specifying the logical channel and the Interrupt User Data received from a higher layer entity and starts the Interrupt Response Timer (T26). At this time, the logical channel is in the DTE INTERRUPT SENT state (i2). In this state, the DTE cannot transmit a further INTERRUPT packet until the outstanding INTERRUPT packet is confirmed with an INTERRUPT CONFIRMATION packet.

The failure to receive an INTERRUPT CONFIRMATION packet before expiration of T26 after transmission of an INTERRUPT packet is considered an error. In this case, the DTE resets the logical channel with the cause indicating "DTE Originated" and the diagnostic "Timer Expired for Interrupt."

See also:

- INTERRUPT packet format (12.3.2 and Figure 18); Interrupt Response Timer (T26) (Table 26);
- Reset procedures (clause 8);
- Interrupt confirmation (6.8.3).

6.8.2 Receiving an interrupt

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

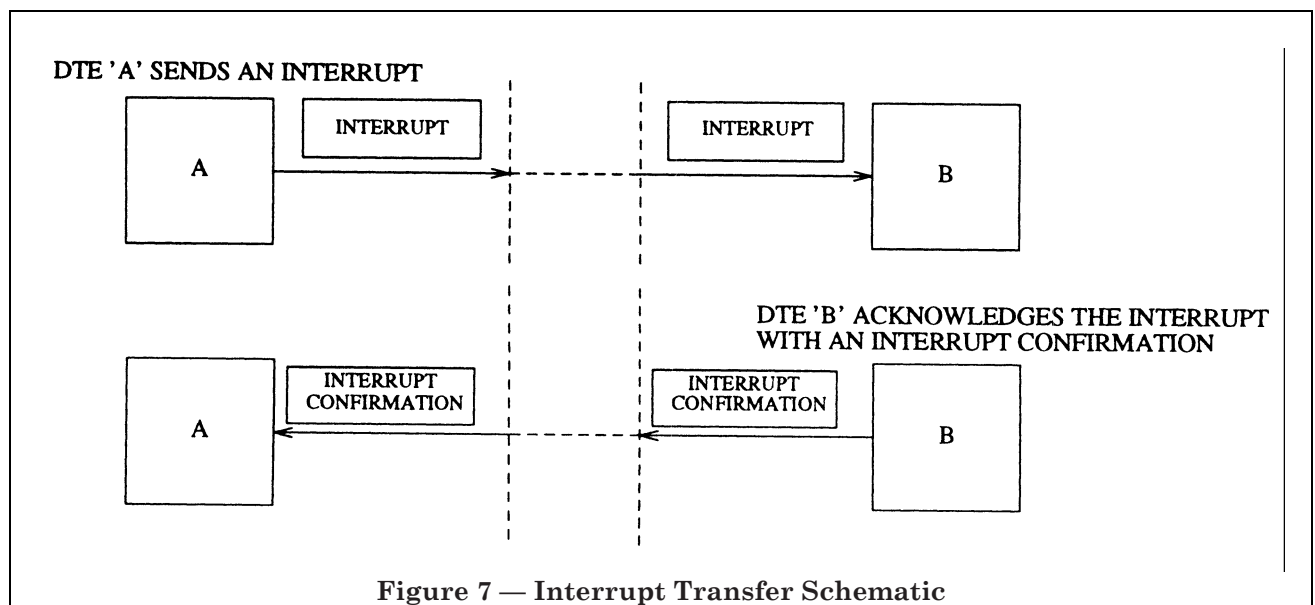


Figure 7 — Interrupt Transfer Schematic

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

See also:

- Reset procedures (clause 8);
- Interrupt confirmation (6.8.3);
- Timers to consider when receiving an INTERRUPT packet (Table 28).

6.8.3 Interrupt confirmation

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

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

See also:

— INTERRUPT CONFIRMATION packet format (12.3.3 and Figure 19).

6.9 Transit delay of DATA packets

Transit delay is an inherent characteristic of a Virtual Call or Permanent Virtual Circuit, common to the two directions of transmission. Transit delay is the DATA packet transfer delay expressed in terms of a mean value.

Selection of transit delay on a per Virtual Call basis and indication to both the calling and called DTEs of the value of the transit delay applying to a given Virtual Call may be made by the means of the Transit Delay Selection And Indication Facility.

See also:

— Optional User Facility for Transit Delay Selection And Indication (13.27).

7 Procedures for flow control

The procedures covering flow control of DATA packets described in this clause apply independently to each logical channel used for a Virtual Call or Permanent Virtual Circuit.

The flow control procedure can apply only in the FLOW CONTROL READY state (d1). Therefore, the flow control procedure is abandoned as a result of a *clearing (Virtual Calls only)*, reset, or restart procedure.

Within state d1, there are four states (two for each direction of flow control) that apply to the flow control procedure. They are the DXE RECEIVE READY (f1), DXE RECEIVE NOT READY (f2), DTE RECEIVE READY (g1), and DTE RECEIVE NOT READY (g2) states, as shown in Figure 38. Table 36 specifies the action taken by the DTE on the receipt of flow control, DATA, and REJECT (if subscribed to) packets from the DXE as applied to the flow control procedure.

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

7.1 Flow control

At the DTE/DXE interface of a logical channel, the transmission of DATA packets is controlled separately for each direction and is based on authorizations from the receiver. Figure 8 shows schematically the flow control procedures discussed here.

On a Virtual Call or Permanent Virtual Circuit, flow control also allows a DTE to limit the rate at which the remote DTE can transmit DATA packets. This is achieved by the receiving DTE controlling the rate at which it accepts packets across the DTE/DXE interface. *In a DTE/DCE environment, it should be noted that there is a network-dependent limit on the number of DATA packets which may be in the network on the Virtual Call or Permanent Virtual Circuit.*

See also:

— Timers to consider when receiving a DATA packet (Table 28).

7.1.1 Numbering of packets

Each DATA packet transmitted across the DTE/DXE interface for each direction of data transmission on a given Virtual Call or Permanent Virtual Circuit is sequentially numbered.

The sequence numbering of DATA packets is performed modulo 8. The packet sequence numbers cycle through the entire range from 0 through 7. The Extended Packet Sequence Numbering Facility may be provided at the DTE/DXE interface. If the Extended Packet Sequence Numbering Facility is selected, the sequence numbering of DATA packets is performed modulo 128 and the packet sequence numbers cycle through the entire range from 0 through 127. The modulo, 8 or 128, is the same for both directions of data transmission and is common to all logical channels in a Packet Layer entity.

Only DATA packets contain this sequence number, which is called the packet send sequence number P(S).

The first DATA packet to be transmitted across the DTE/DXE interface for a given direction of data transmission, when the logical channel has just entered the FLOW CONTROL READY state (d1), has a P(S) equal to 0. Subsequent DATA packets are numbered consecutively.

See also:

— Optional User Facility for Extended Packet Sequence Numbering (13.2).

7.1.2 Window description

At the DTE/DXE interface of a logical channel used for a Virtual Call or Permanent Virtual Circuit and for each direction of data transmission, a window is defined as the (modulo) ordered set of W consecutive packet send sequence numbers $P(S)$ of the DATA packets authorized to cross the interface.

The packet send sequence number of the first of the W packets in the window is referred to as the “lower window edge.” When a Virtual Call or Permanent Virtual Circuit has just entered the FLOW CONTROL READY state (d1), the window related to each direction of data transmission has a lower window edge equal to 0. The “upper window edge” is the $P(S)$ of the last of the W packets authorized to cross the interface.

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

The standard default window size W is 2 for each direction of data transmission at the DTE/DXE interface. In addition, other (nonstandard) default window sizes may be available.

From the combination of the standard default and the list of nonstandard defaults, if any, a window size shall be selected for each direction of data transmission. *For Virtual Calls, this choice applies in common to all logical channels at the DTE/DXE interface. For Permanent Virtual Circuits, this choice is made separately for each logical channel.* These selections are agreed to for a period of time with the DXE. *In addition, negotiation of the window size on a per Virtual Call basis is allowed if the Flow Control Parameter Negotiation Facility has been subscribed to.*

See also:

- Optional User Facility for Nonstandard Default Window Sizes (13.10);
- Optional User Facility for Flow Control Parameter Negotiation (13.12).

7.1.3 Flow control principles

When the sequence number $P(S)$ of the next DATA packet to be transmitted by a DTE or DXE is within the window, the DTE or DXE is authorized to transmit this DATA packet. When the $P(S)$ of the next DATA packet to be transmitted is outside of the window, the DTE or DXE shall not transmit a DATA packet across the DTE/DXE interface.

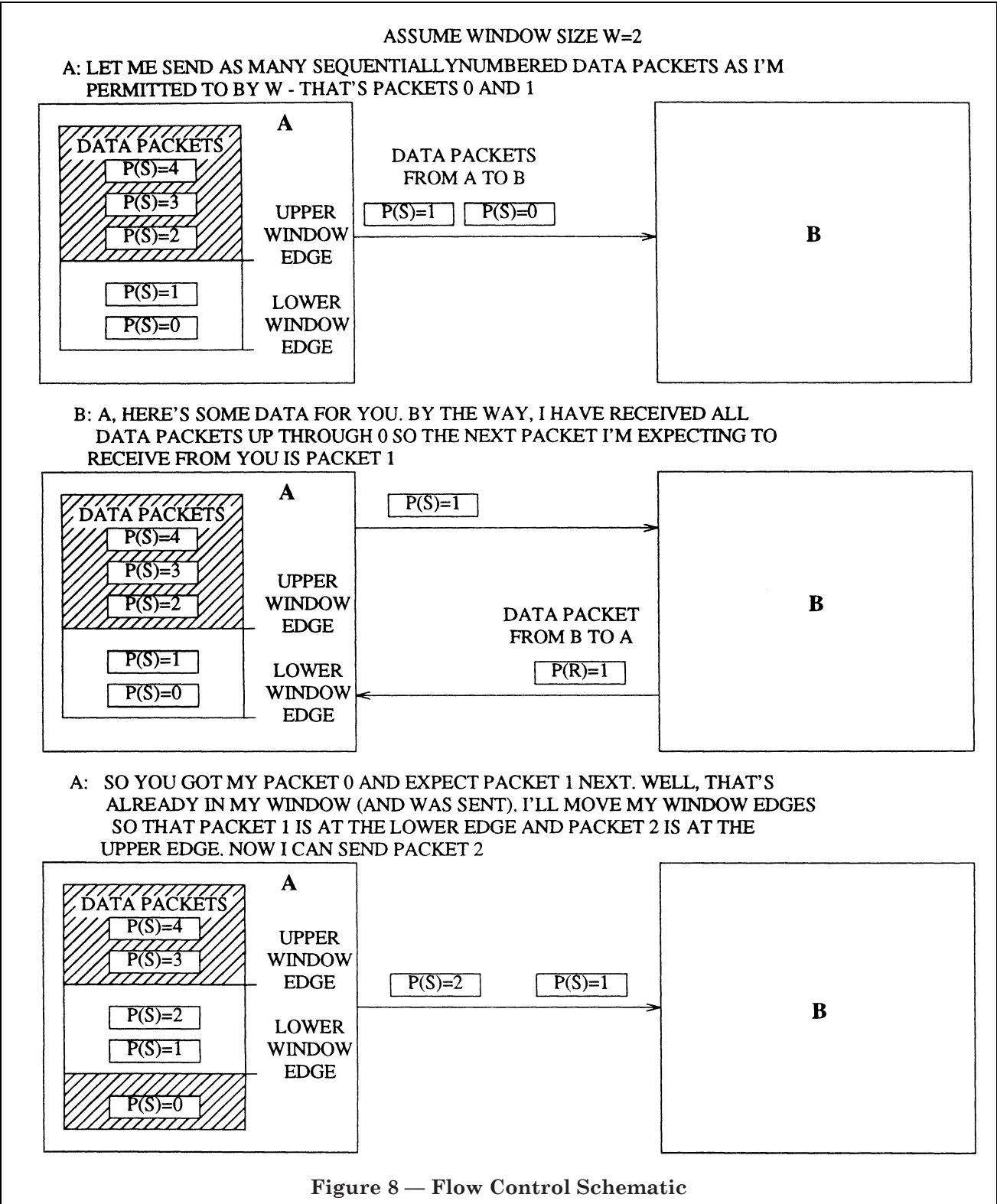
When the sequence number $P(S)$ of the DATA packet received by a DTE or DXE is next in sequence and is within the window, the DTE or DXE will accept this DATA packet. Receipt of a DATA packet containing a $P(S)$ that is out of sequence [i.e., there is a duplicate or a gap in the $P(S)$ numbering], outside the window, or not equal to 0 for the first DATA packet after entering the FLOW CONTROL READY state (d1) is considered by the DTE or DXE as a procedure error. *In a DTE/DCE environment, a DCE will reset the logical channel with a cause indicating “Local Procedure Error.”* A DTE will reset the logical channel with a cause indicating “DTE Originated.” In either case, the diagnostic will be “Invalid $P(S)$.”

As an alternative for when a received DATA packet contains a $P(S)$ that is out of sequence but inside the window, a DTE may use procedures b) or c) discussed in 11.3.

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

The packet receive sequence number, $P(R)$, is conveyed in DATA, RECEIVE READY (RR), RECEIVE NOT READY (RNR), and REJECT (if subscribed to) packets.

The value of a received $P(R)$ should be greater than or equal to the last $P(R)$ received by a DTE or DXE and less than or equal to the $P(S)$ of the next DATA packet to be transmitted by that DTE or DXE. If this is not the case, the DTE or DXE will consider the receipt of this $P(R)$ as a procedure error and will reset the logical channel. *A DCE will indicate the cause as “Local Procedure Error.”* A DTE will indicate the cause as “DTE Originated.” In either case, the diagnostic will be “Invalid $P(R)$.”



The $P(R)$ returned in any of the above-mentioned packets is less than or equal to the $P(S)$ (modulo 8, or 128 when extended) of the next DATA packet expected. It implies that the DTE or DXE transmitting the $P(R)$ has accepted at least all DATA packets up to and including the packet numbered $P(R) - 1$.

See also:

- RECEIVE READY packet (7.1.5);
- RECEIVE NOT READY packet (7.1.6);
- Reset procedures (clause 8);
- Receipt of erroneous DATA packets (11.3);
- Optional User Facility for Packet Retransmission (13.4);
- Optional User Facility for Extended Packet Sequence Numbering (13.2).

7.1.4 Delivery confirmation

When the D-bit is set to 0 in a DATA packet having $P(S) = p$, the significance of the returned $P(R)$ corresponding to that DATA packet (i.e., $P(R) \geq p + 1$) is a local updating of the window across the Packet Layer interface. *In a DTE/DCE environment, the returned $P(R)$ does not signify that a $P(R)$ has been received from the remote DTE. Furthermore, the achievable throughput is not constrained by the DTE-to-DTE round-trip delay across the network(s).*

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

If the DTE is unwilling to use the D-bit procedure and receives a DATA packet with the D-bit set to 1, then it shall reset the logical channel with a cause indicating “DTE Originated” and the diagnostic “D-bit Procedure Not Supported.”

To achieve a greater degree of reliability, DTEs may use the D-bit procedure to signify receipt of data by a higher layer entity. Such use requires prior agreement between the two DTEs. When using this procedure, the sending Packet Layer sets the D-bit of the last DATA packet in an M-bit sequence to 1 if end-to-end receipt confirmation by a higher layer entity is desired. On receiving the last DATA packet of an M-bit sequence with the D-bit set to 1, the Packet Layer shall not return the corresponding $P(R)$ until the data in this packet has been acknowledged by a higher layer entity. (It is for further study whether the Packet Layer need wait for acknowledgement by a higher layer entity of data in a DATA packet with its D-bit set to 1 when the packet is not the last one in an M-bit sequence.) When this acknowledgement is received, the Packet Layer shall return this $P(R)$ as soon as possible (e.g., without waiting for further DATA packets) to avoid the possibility of deadlocks. A DATA, RR, RNR, or REJECT (if subscribed to) packet may be used to convey the $P(R)$ (see note 2 to 7.1.6). *Likewise, in a network environment, the DCE is required to send a $P(R)$ to the DTE as soon as possible after the $P(R)$ is received from the remote DTE.*

NOTE 1 When a $P(R)$ for a DATA packet with the D-bit set to 1 is outstanding, local updating of the window at the DTE/DCE interface will be deferred for subsequent DATA packets with the D-bit set to 0. Some networks may also defer updating the window for previous DATA packets (within the window) with the D-bit set to 0 until the corresponding $P(R)$ for the packet with the outstanding D-bit set to 1 is transmitted to the DTE.

NOTE 2 In a DTE/DCE environment, $P(R)$ values corresponding to the data contained in DATA packets with the D-bit set to 1 need not be the same at the DTE/DCE interfaces at each end of a Virtual Call or Permanent Virtual Circuit.

NOTE 3 If the DTE has sent DATA packets with the D-bit set to 0, then the DTE should not wait for local updating of the window before initiating a resetting or clearing procedure.

See also:

- D-bit (6.3);
- M-bit sequence (6.4);
- Reset procedures (clause 8);
- Clearing procedures (5.5).

7.1.5 RECEIVE READY (RR) packets

RECEIVE READY (RR) packets are used by both a DTE and DXE to indicate a readiness to receive the W DATA packets within the window starting with $P(R)$, where $P(R)$ is indicated in the RR packet.

NOTE The transmission of an RR packet with a particular $P(R)$ value is not to be taken as a demand for retransmission of DATA packets which have already been transmitted.

See also:

- RECEIVE READY packet format (12.4.1 and Figure 20).

7.1.6 RECEIVE NOT READY (RNR) packets

RECEIVE NOT READY (RNR) packets are used by both a DTE and DXE to indicate a temporary inability to accept additional DATA packets for a given Virtual Call or Permanent Virtual Circuit. A DTE or DXE receiving an RNR packet stops transmitting DATA packets on the indicated logical channel, but updates the window using the P(R) value of the RNR packet if the P(R) is valid. The receive-not-ready situation indicated by the transmission of an RNR packet is cleared by the transmission in the same direction of a RECEIVE READY or a REJECT (if subscribed to) packet, or by the initiation of a reset procedure.

NOTE 1 The transmission of an RR packet after transmission of an RNR packet is not to be taken as a demand for retransmission of DATA packets which have already been transmitted.

NOTE 2 The RNR packet may be used to convey across the DTE/DXE interface the P(R) value corresponding to a DATA packet which had the D-bit set to 1 in the case that additional DATA packets cannot be accepted.

See also:

- RECEIVE NOT READY packet format (12.4.2 and Figure 21);
- RECEIVE READY packet (7.1.5);
- Reset procedures (clause 8).

7.2 Throughput characteristics and throughput classes

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

The optimal conditions to maximize the steady state throughput include the following:

- a) the access line characteristics of the local and remote interfaces do not constrain the throughput class;
- NOTE 1 In particular, because of the overhead due to the frame and packet headers, when the throughput class corresponding to the user class of service (i.e., access-line transmission rate) of the DTE is applicable to a Virtual Call or Permanent Virtual Circuit, a steady state throughput equal to that throughput class can never be reached.
- b) the window sizes at the local and remote interfaces do not constrain the throughput;
 - c) the traffic characteristics of other logical channels at the local and remote interfaces do not constrain the throughput;
 - d) the receiving DTE is not flow controlling the DXE such that throughput class is not attainable;
 - e) the transmitting DTE sends only DATA packets that have the maximum User Data Field length; and
 - f) the D bit is not set to 1.

The Extended Packet Sequence Numbering (see 13.2), Nonstandard Default Packet Sizes (see 13.9), Nonstandard Default Window Sizes (see 13.10) and/or the Flow Control Parameter Negotiation (see 13.12) facilities may be needed to achieve high values of steady state throughput, especially for Virtual Calls or Permanent Virtual Circuits having high transit delay.

The throughput class is expressed in bits per second. At a DTE/DXE interface, the maximum User Data Field length is specified for a Virtual Call or Permanent Virtual Circuit and, thus, the throughput class can be interpreted by the DTE as the number of full DATA packets/second at the DTE/DXE interface.

In the absence of the Default Throughput Classes Assignment Facility, the default throughput classes for both directions of data transmission correspond to the user class of service (i.e., the access-line transmission rate) of the DTE but do not exceed the maximum throughput class supported by the DXE. *In addition, negotiation of the throughput classes on a per Virtual Call basis is allowed if one of the Throughput Class Negotiation facilities has been subscribed to.*

NOTE 2 The sum of throughput classes of all Virtual Calls and Permanent Virtual Circuits supported at a DTE/DXE interface may be greater than the access-line transmission rate.

See also:

- D-bit (6.3 and 7.1.4);
- Procedures for flow control (clause 7);
- Optional User Facility for Default Throughput Classes Assignment (13.11);
- Optional User Facilities for Throughput Class Negotiation (13.13).

8 Procedures for reset

The reset procedures described in this clause apply independently to each logical channel existing at the DTE/DXE interface.

The reset procedure is used to reinitialize a Virtual Call or Permanent Virtual Circuit at the DTE/DXE interface has just been reset, the following actions relative to the logical channel are taken.

- a) With respect to DATA packets:
 - those that have been transmitted are removed from the window,
 - those that have not been transmitted but are contained in an M-bit sequence for which some DATA packets were transmitted are flushed from the queue of DATA packets awaiting transmission, and
 - those that have been received but which do not constitute an entire M-bit sequence are flushed from the M-bit-sequence reassembly area (as an alternative, these packets may be passed to a higher layer entity with an indication that they do not constitute an entire M-bit sequence).
- 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 receive-not-ready 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 value (these include T24, T25, T26, T27, R25, and R27).

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

Figure 9 gives a schematic view of the reset procedure.

The reset procedure can apply only in the DATA TRANSFER state (p4). In any other state, the reset procedure is abandoned. For example, when a *clearing (Virtual Calls only)* or restarting procedure is initiated, RESET REQUEST and RESET INDICATION packets are left unconfirmed. There are three states within p4 that apply to the reset procedure. They are the FLOW CONTROL READY (d1), DTE RESET REQUEST (d2), and DXE RESET INDICATION (d3) states, as shown in Figure 36. *A Virtual Call logical channel is in state d1 when it enters state p4. A Permanent Virtual Circuit logical channel is continuously in state d1 except during a reset or restart procedure.*

Table 34 specifies the action taken by the DTE on the receipt of packets from the DXE as applied to the reset procedure.

See also:

- M-bit sequences (6.4 and Figure 10);
- Flow control window (7.1.2);
- Timer parameters (Table 26);
- Retransmission parameters (Table 27).

8.1 Originating a reset request

A DTE indicates a reset request at any time by transmitting across the DTE/DXE interface a RESET REQUEST packet specifying the logical channel and by starting the Reset Request Response Timer (T22). The logical channel is then in the DTE RESET REQUEST state (d2). In this state, the DTE discards DATA, INTERRUPT, INTERRUPT CONFIRMATION, RECEIVE READY, RECEIVE NOT READY, and REJECT packets for the logical channel. Therefore, higher layer entities must be able to cope with the various possible situations that may occur.

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

See also:

- RESET REQUEST packet format (12.5.1 and Figure 22);

- Reset Request Response Timer (T22) (Table 26);
- Reset Request Retransmission Count (R22) (Table 27);
- Clearing procedures (5.5);
- Receiving a reset indication (8.2);
- Reset collision (8.3);
- Reset confirmation (8.4).

8.2 Receiving a reset indication

Upon receiving a RESET INDICATION packet, the indicated logical channel is in the DXE RESET INDICATION state (d3). In this state, a DTE considers subsequent receipt of any DATA, INTERRUPT, INTERRUPT CONFIRMATION, RECEIVE READY, RECEIVE NOT READY, or REJECT packets as an error. It discards any such packet and transmits a RESET REQUEST packet with a cause indicating “DTE Originated” and the diagnostic “Packet Type Invalid For State d3.”

The RESET INDICATION packet specifies the reason for the resetting. The resetting cause code, as well as the diagnostic code and an indication that a resetting procedure has taken place, is passed to a higher layer entity.

NOTE In a DTE/DTE environment, the RESET INDICATION packet received by a DTE is the same as the RESET REQUEST packet transmitted by the other DTE.

In a DTE/DCE environment, if a momentary failure occurs within the network, then a RESET INDICATION packet with the cause “Network Congestion” will be received from the DCE. If the network has a temporary inability to handle data traffic, then a RESET INDICATION packet with the cause “Network Out Of Order” will be received from the DCE. In this case, when the network can handle data traffic again, a Permanent Virtual Circuit will be reset with the cause “Network Operational.”

After processing the RESET INDICATION packet, the DTE transmits a RESET CONFIRMATION packet across the DTE/DXE interface.

See also:

- RESET INDICATION packet format (12.5.1 and Figure 22);
- Resetting cause (12.5.1);
- Reset collision (8.3);
- Reset confirmation (8.4);
- Timers to consider when receiving a RESET INDICATION packet (Table 28).

8.3 Reset collision

Reset collision occurs when a DTE transmits a RESET REQUEST packet (as described in 8.1) and then receives a RESET INDICATION packet (as described in 8.2) for the same logical channel. In this case, a DTE does not transmit nor expect to receive a RESET CONFIRMATION packet and considers that the resetting is completed.

When the resetting procedure is completed, the logical channel is in the FLOW CONTROL READY state (d1).

8.4 Reset confirmation

When a DTE is prepared to acknowledge a reset, it transmits across the DTE/DXE interface a RESET CONFIRMATION packet. At this time, the resetting procedure is considered completed.

Having initiated a resetting procedure, the DTE considers the resetting procedure completed when it receives a RESET CONFIRMATION packet.

When the resetting procedure is completed, the logical channel is in the FLOW CONTROL READY state (d1).

In a network environment, the RESET CONFIRMATION packet received from a DCE can only be interpreted universally as having local significance. However, within some networks, reset confirmation may have end-to-end significance.

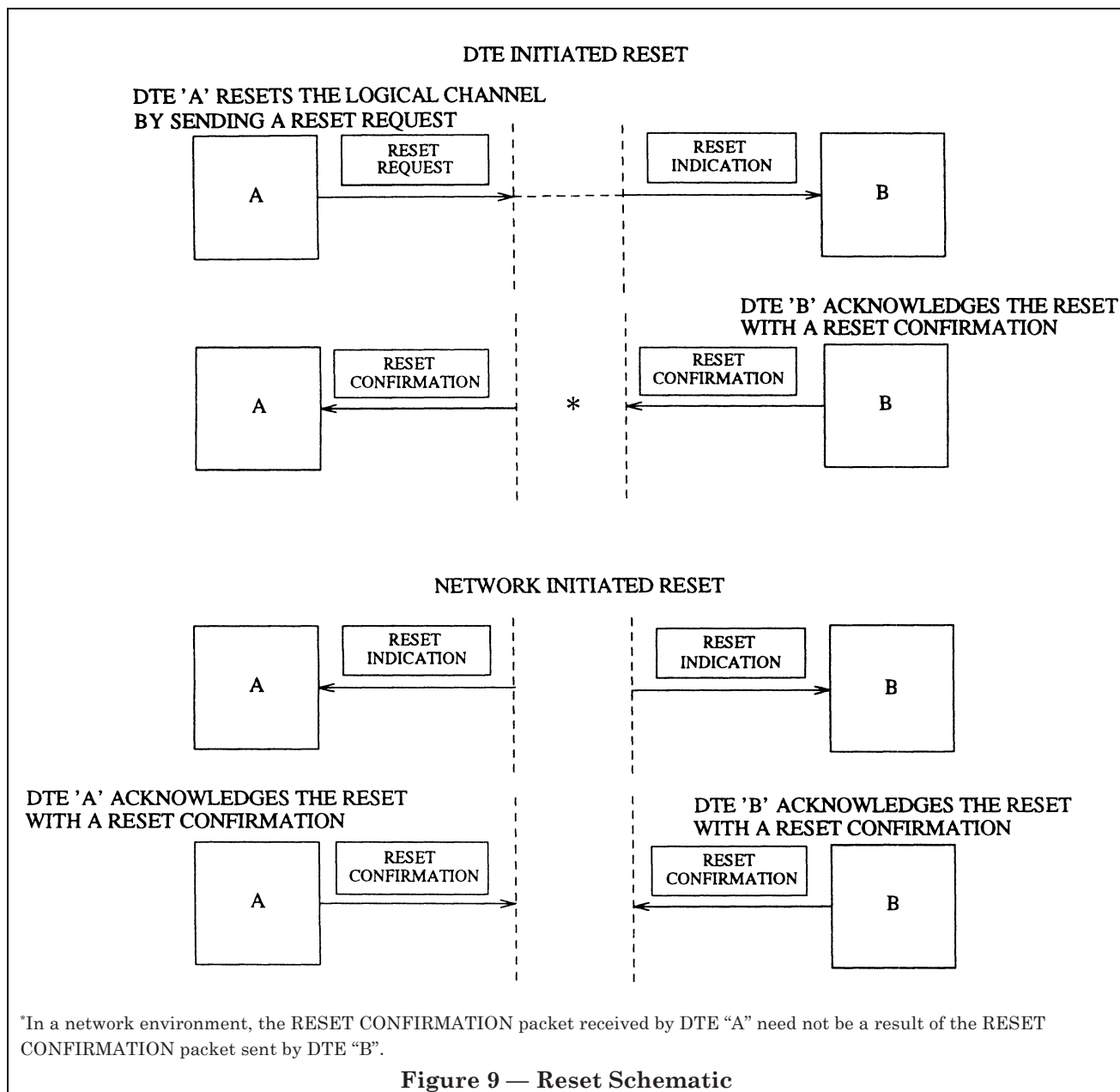
See also:

- RESET CONFIRMATION packet format (12.5.2 and Figure 23).

9 Effects of clear, reset, and restart procedures on the transfer of packets

This clause pertains to a network environment.

All DATA and INTERRUPT packets generated by a DTE (or the network) before initiation by the DTE or the DCE of a *clear (Virtual Calls only)*, reset, or restart procedure at the local interface will either be delivered to the remote DTE before the DCE transmits the corresponding indication on the remote interface or be discarded by the network.



No DATA or INTERRUPT packets generated by a DTE (or the network) after the completion of a *restart (Permanent Virtual Circuits only)* or reset procedure at the local interface will be delivered to the remote DTE before the completion of the corresponding reset procedure at the remote interface.

When a DTE initiates a *clear (Virtual Calls only)*, reset, or restart procedure on its local interface, all DATA and INTERRUPT packets which were generated by the remote DTE (or the network) before the corresponding indication is transmitted to the remote DTE will either be delivered to the initiating DTE before DCE confirmation of the initial *clear (Virtual Calls only)*, reset, or restart request, or be discarded by the network.

NOTE The maximum number of DATA packets which may be discarded is a function of network end-to-end delay and throughput characteristics and, in general, has no relation to the local window size. For Virtual Calls and Permanent Virtual Circuits on which all DATA packets are transferred with the D-bit set to 1, the maximum number of DATA packets which may be discarded in one direction of transmission is not larger than the window size of the direction of transmission.

10 Effects of Layers 1 and 2 on the Packet Layer

Changes of operational states of Layers 1 and/or 2 of the DTE/DXE interface do not implicitly change the state of any logical channel in a Packet Layer entity. Such changes, when they occur, are explicitly indicated at the Packet Layer by the use of restart, *clear (Virtual Calls only)*, or reset procedures, as appropriate.

An out-of-order condition on Layers 1 and/or 2 is defined as a condition in which:

- a) frames cannot be transmitted or cannot be received across the DTE/DXE interface because of abnormal conditions caused, for instance, by a line fault between the DTE and DXE; or
- b) the DTE has received or transmitted a Data Link Layer DISC command.

NOTE Short Layer 1 outages (e.g., momentary loss of carrier) are not considered an out-of-order condition and the Data Link Layer and Packet Layer are not informed.

When the multilink procedure is used, an out-of-order condition is considered as having occurred when it is present at the same time for every single link procedure of the DTE/DXE interface, when the multilink resetting procedure is performed, or upon loss of multilink frame(s).

In terms of the OSI connection-mode Data Link Service, an out-of-order condition is considered to have occurred when the Data Link connection is released.

When such an out-of-order condition is detected, the DTE considers *those logical channels used for Virtual Calls to have been cleared and those used for Permanent Virtual Circuits to have been reset*.

In a DTE/DCE environment, the DCE will transmit to the remote end:

- a) *for each Permanent Virtual Circuit, a RESET INDICATION packet with the cause "Out Of Order;" and*
- b) *for each existing Virtual Call, a CLEAR INDICATION packet with the cause "Out Of Order."*

During the out-of-order condition, the DCE will:

- a) *for any incoming Virtual Call, clear the call with the cause "Out Of Order;"*
- b) *for any DATA or INTERRUPT packet received from the remote DTE on a Permanent Virtual Circuit, reset the Permanent Virtual Circuit with the cause "Out Of Order;" and*
- c) *for a RESET REQUEST packet received from the remote DTE on a Permanent Virtual Circuit, confirm the reset procedure to the remote DTE by either a RESET CONFIRMATION or RESET INDICATION packet.*

When the out-of-order condition is recovered, the DTE should initiate the restart procedure. *For each Permanent Virtual Circuit in a DTE/DCE environment, each remote DTE will receive a RESET INDICATION packet.*

See also:

- Clearing procedures (5.5);
- Reset procedures (clause 8);
- Restart procedures (clause 4).

11 Error handling

An error as defined at the Packet Layer can be classified as follows:

- a) syntactical errors — receipt of a packet that does not conform to the format specifications of the Packet Layer; examples of syntactical errors are:
 - receipt of any packet with an invalid General Format Identifier,

- receipt of any packet with an unassigned Logical Channel Identifier (this includes any packets, other than Restart, Registration, and DIAGNOSTIC packets, that are received with a Logical Channel Identifier of 0),
 - receipt of any packet with an invalid Packet Type Identifier, and
 - receipt of a DATA packet with data that exceeds the maximum User Data Field length permitted on that logical channel;
- b) logical errors — receipt of a packet that is not an acceptable input to the current state of the logical channel or whose value of P(R) or P(S) is invalid; examples of logical errors are:
- receipt of a CONFIRMATION packet (CLEAR, RESET, RESTART, or REGISTRATION) when the corresponding REQUEST packet has not been sent out,
 - receipt of a second interrupt packet before an INTERRUPT CONFIRMATION packet has been sent,
 - receipt of any packet whose value of P(R) is not greater than or equal to the last P(R) received or is not less than or equal to the next value of P(S) to be transmitted across the DTE/DXE interface, and
 - receipt of a DATA packet whose value of P(S) is outside the window or is inside the window but out of sequence; and
- c) transmission errors — errors resulting from the loss or delay of packets; examples of transmission errors are:
- nonreceipt of an appropriate response packet (e.g., a RESTART CONFIRMATION) after transmission of a RESTART REQUEST packet and before expiration of timer T20,
 - nonreceipt of an appropriate response packet (e.g., a CALL CONNECTED) after transmission of a CALL REQUEST packet and before expiration of timer T21,
 - nonreceipt of an appropriate response packet (e.g., a RESET CONFIRMATION) after transmission of a RESET REQUEST packet and before expiration of timer T22,
 - nonreceipt of an appropriate response packet (e.g., a CLEAR CONFIRMATION) after transmission of a CLEAR REQUEST packet and before expiration of timer T23,
 - nonreceipt of an appropriate response packet (e.g., an INTERRUPT CONFIRMATION) after transmission of an INTERRUPT packet and before expiration of timer T26, and
 - nonreceipt of an appropriate response packet (e.g., a REGISTRATION CONFIRMATION) after transmission of a REGISTRATION REQUEST packet and before expiration of timer T28.

The above list of examples is not meant to cover all error conditions. Table 31 through Table 36 summarize the actions a DTE follows upon detection of a syntactical or logical error. Table 26 and Table 27 summarize the actions a DTE follows upon detection of a transmission error.

11.1 The DIAGNOSTIC packet

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

The DIAGNOSTIC packet is used to indicate error conditions under circumstances where the usual methods of indication (i.e., reset, clear, and restart with cause and diagnostic) are inappropriate (see Table 31 and Table 32). The DIAGNOSTIC packet supplies information on error situations which are considered unrecoverable at the Packet Layer. Upon receipt of a DIAGNOSTIC packet, the Packet Layer passes an indication of its receipt and the associated error information to a higher layer entity.

A DIAGNOSTIC packet is issued only once per particular instance of an error condition. No confirmation is required to be issued by the DTE on receipt of a DIAGNOSTIC packet.

See also:

- DIAGNOSTIC packet format (12.7 and Figure 26);
- Diagnostic codes (Table 24 and Table 25);
- Reset procedures (clause 8);
- Clearing procedures (5.5);
- Restart procedures (clause 4).

11.2 Nonreceipt of window-rotation information

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

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

- a) loss of transmitted DATA packets, up to an entire window's worth of DATA packets (in the event that such a loss occurs, the transmitting DTE will not receive packets that rotate the window);
- b) loss of a packet containing a P(R) that rotates the window [packets used for conveying a P(R) are the RR, RNR, DATA, and REJECT (if subscribed to) packets];
- c) less than a full window's worth of DATA packets with the D-bit set to 0 was transmitted (the DXE, under normal circumstances, is only required to effect window rotation to meet the throughput class and to acknowledge DATA packets with the D-bit set to 1); and
- d) the DXE is effecting flow control by allowing the window to close (i.e., without sending an RNR packet) when receiving DATA packets with the D-bit set to 0 because of a temporary lack of resources or other reasons.

Failure to receive window-rotation information, depending on the reason, can lead to a condition in which the transmitting DTE is "flow-control inhibited" at the Packet Layer. If the window has closed, then the transmitting DTE may not transmit any more DATA packets because of the flow-control mechanisms defined in 7.1. The DTE remains flow-control inhibited until its transmission window is rotated and it is not explicitly flow controlled by an RNR packet. Of particular concern are items a) and b) above, since the DTE can remain flow-control inhibited indefinitely. This condition is referred to as "flow-control lockout."

See also:

- Window description (7.1.2);
- Flow control principles (7.1.3).

11.2.1 Optional procedures at the transmitting DTE

To effect recovery from nonreceipt of window-rotation information, a DTE may start a Window Rotation Timer (T25) when a DATA packet is transmitted across the DTE/DXE interface. When a P(R) is received that rotates the window, the timer is restarted if there are any previously-transmitted DATA packets still in the window or if additional DATA packets are then transmitted; otherwise, the timer is cancelled. If a P(R) that rotates the window is not received before expiration of T25, then the transmitting DTE should:

- a) reset the logical channel; or
- b) retransmit all previously-transmitted DATA packets in the window, and restart the timer. If the number of retransmissions exceeds a maximum number R25, then the DTE should reset the logical channel.

NOTE 1 This retransmission of DATA packets has nothing to do with the Packet Retransmission Optional User Facility or the use of REJECT packets.

NOTE 2 A DTE [except if it is operating with one of the alternative procedures described in item b) or c) of 11.3] and a DCE will consider receipt of a DATA packet with a P(S) that is out of sequence or outside the window as a procedure error and will reset the logical channel.

When resetting the logical channel as in a) or b) above, the DTE indicates the cause as "DTE Originated" with the diagnostic "Timer Expired Or Retransmission Count Surpassed For DATA Packet Transmission."

NOTE 3 A DCE or DTE receiving DATA packets is not obligated to rotate the window in such a timely fashion so as to prevent the transmitting DTE's T25 timer from expiring [for example, see items c) and d) of 11.2]. Therefore, the procedure outlined above should be used with caution.

See also:

- Window Rotation Timer (T25) (Table 26);
- Data Packet Retransmission Count (R25) (Table 27);
- Reset procedures (clause 8).