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ISO 8208 : 1987

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British Standard Specification for

**X.25 packet level protocol for
data terminal equipment for information
processing systems**

Protocole X 25 de niveau paquet pour les terminaux de données des systèmes de
traitement de l'information

Paketvermittlungsprotokoll X.25 für Datenendeinrichtungen für
Informationsverarbeitungssysteme

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National foreword

This British Standard, prepared under the direction of the Information Systems Technology Standards Policy Committee, is identical with ISO 8208 : 1987 'Information processing systems — Data Communications — X.25 Packet Level Protocol for Data Terminal equipment' published by the International Organization for Standardization (ISO). It supersedes DD 117 : 1985 which is withdrawn.

Cross-references

International standard	Corresponding British Standard
ISO 7776 : 1986	BS 5397 High level data link control (HDLC) procedures Part 7 : 1985 Specification for X.25 LAPB-compatible DTE data link procedures
ISO 8348 : 1987	BS 7220 : 1989 Open System Interconnection : Network Service definition (incorporating connectionless-mode transmission and network layer addressing) (Identical)

The Technical Committee has reviewed the provisions of CCITT Recommendations X.2, X.25, X.29, X.32, X.75, X.96, X.244 and D.12, to which reference is made in the text, and has decided that they are acceptable for use in connection with this standard. Copies are available from BSI Sales, Linford Wood, Milton Keynes, MK14 6LE.

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Information processing systems — Data communications — X.25 Packet Level Protocol for Data Terminal Equipment

1 Scope and field of application

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

This International Standard covers DTE operation at the Packet Level when accessing a public or private packet-switched network conforming to CCITT Recommendation X.25 by means of a dedicated path or a circuit-switched connection. It also covers the additional Packet Level 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 or a circuit-switched connection.

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

2 References

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

ISO 8348, *Information processing systems — Data communications — Network Service Definition.*

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

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

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

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

CCITT Recommendation X.75, *Terminal and transit call control procedures and data transfer system on international circuits between packet-switched data networks.*

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

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

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

3 General considerations

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

This International Standard presents a description of the Packet Level interface for "Virtual Call" service and "Permanent Virtual Circuit" service. As designated in CCITT Recommendation X.2, these are essential (E) services to be provided by all networks.

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); and
- f) guidelines for applying this International Standard to private networks that connect to a packet-switched public data network and that may also offer an X.25 interface to a DTE (see the annex).

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 that pertain to one service or to one interface type are not italicized; the appropriate environment is denoted at the beginning of the clause);
- d) terms not explicitly defined within this International Standard are taken from the CCITT X-series Recommendations;
- e) tables are located in the text at the point where they are referenced; and
- f) figures are located at the end of the document.

The Packet Level procedures in this International Standard are based on an underlying Link Level service (for example, that provided by ISO 7776) that provides:

- a) a negligible residual-bit-error rate;
- b) a negligible out-of-sequence rate; and
- c) a negligible packet-loss and duplication rate.

The Packet Level 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 Level errors;

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

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

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

- a) conform fully to CCITT Recommendation X.25 (1984) 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 Level;
- d) align the services provided by the Packet Level with the Network Layer services defined for Open Systems Interconnection; and
- e) follow the organization of text in CCITT Recommendation X.25.

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

3.1 Limitations for compatibility with X.25-1980

The Packet Level procedures and formats specified in this International Standard are compatible with the 1984 version of CCITT Recommendation X.25. For DTEs needing to operate with the 1980 version of Recommendation X.25, the following 1984 capabilities are not used:

- a) maximum User Data Field lengths in DATA packets of 2048 and 4096 octets (see 6.2); for 1980 operation, the largest maximum User Data Field length allowed is 1024 octets;
- b) Facility Fields in CALL REQUEST, INCOMING CALL, CALL ACCEPTED, and CALL CONNECTED packets with a length from 64 to 109 octets (see 12.2.1.1 and 12.2.2.1); for 1980 operation, this field is limited to 63 octets and bit 7 of the Facility Length Field shall be set to 0;

- c) cause codes with bit 8 set to one in CLEAR REQUEST/INDICATION, RESET REQUEST/INDICATION, and RESTART REQUEST/INDICATION packets (see 12.2.3.1, 12.5.1, and 12.6.1, respectively); for 1980 operation, this bit shall be set to zero;
- d) nonzero Address Length and Facility Length Fields in CLEAR REQUEST and CLEAR INDICATION packets (see 12.2.3.2); for 1980 operation, these length fields shall indicate zero octets and may only be present when the packet contains a Clear User Data Field;
- e) the extended format for CLEAR CONFIRMATION packets (see 12.2.4.2); for 1980 operation, only the basic format may be used;
- f) Interrupt User Data Fields in INTERRUPT packets containing from two to 32 octets (see 12.3.2); for 1980 operation, this field shall contain exactly one octet;
- g) the following optional user facilities:

- On-line Facility Registration (see 13.1),
- Local Charging Prevention (see 13.20),
- Network User Identification (see 13.21),
- Charging Information (see 13.22),
- Hunt Group (see 13.24),
- Call Redirection (see 13.25),
- Called Line Address Modified Notification (see 13.26),
- Call Redirection Notification (see 13.27), and
- Transit Delay Selection And Indication (see 13.28);

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 Differences in DTE/DTE and DTE/DCE operation

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

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

- b) *the Diagnostic Code Field in RESTART REQUEST, CLEAR REQUEST, and RESET REQUEST packets shall be supplied even if it indicates "No Additional Information" (that is, although specific diagnostics are defined for particular error situations, a DTE may use more general codes as discussed in note 2 of figure 14B);*
- 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 should not be transmitted; and*
- d) *upon notification that the Link Level has completed its initialization procedures or that it has recovered from a failure in which the Link Level was in the disconnected phase, the DTE shall transmit a RESTART REQUEST packet across the DTE/DXE interface.*

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

- a) *One of the DTEs shall act as a DCE for*
- *logical channel selection during Virtual Call setup (see figure 1),*
 - *resolution of Virtual Call collision (see 5.2.5).*

(This choice is made independently for each of the DTE's Packet Level entities; see 3.6.)

Sub-clause 4.5 shows how the restart procedure 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 must 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 either 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 the optional Fast Select Facility (see 13.16) shall be agreed to by both DTEs prior to transmission of any call setup packets which utilize this facility. (In a DTE/DCE environment, such prior agreement is not required — a DTE may always use this facility at call setup.)
- i) A called DTE which subscribes to the Flow Control Parameter Negotiation Facility (see 13.12) and/or the Throughput Class Negotiation Facility (see 13.13) will not receive, in an INCOMING CALL packet, a facility indication from which to negotiate if the calling DTE is satisfied with the default values and, thus, has not included the facility request in its CALL REQUEST packet. In a similar manner, a calling DTE which subscribes to these facilities will not

receive, in a CALL CONNECTED packet, a facility indication if the called DTE is satisfied with the values in the INCOMING CALL packet and, thus, has not included a facility request in its CALL ACCEPTED packet. (In a DTE/DCE environment, these facility indications are always present if the DTE has subscribed to these facilities.)

3.3 Operation over circuit-switched connections

When communications between a DTE and DXE involves a circuit-switched connection (e.g., through a circuit-switched public data network or through the public switched telephone network), identification procedures may be required. Such procedures, including those at the Packet Level, are being pursued in conjunction with the CCITT work on Recommendation X.32.

Most communications over a circuit-switched connection are between DTEs 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 Level operation. In some cases, however, it may be desirable to allow for random communications, where one DTE accesses another DTE 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 Level 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 figure 6 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 (e.g., through the use of the On-line Facility Registration Facility — see 13.1) are being pursued in conjunction with the CCITT work on Recommendation X.32.

3.4 External Packet Level interactions

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

- a) requesting, of the Link Level, transmission of outgoing packets;
- b) receiving, from the Link Level, incoming packets;
- c) accepting requests from a higher level entity to initiate certain Packet Level protocol procedures including:

- initialize the Packet Level (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 Level protocol can, on its own accord, *terminate* a Virtual Call or reinitialize a logical channel; and

- d) reporting to a higher level entity the occurrence of certain Packet Level 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 Level also provides to the higher layer entity any data associated with these events. In addition, the Packet Level may also signal the status of the items listed in (c) above.

3.5 Logical channels

To enable simultaneous Virtual Calls and/or Permanent Virtual Circuits, logical channels are used. Each Virtual Call and Permanent Virtual Circuit is assigned a Logical Channel Identifier,¹⁾ which is a number in the range from 1 through 4095. *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 may 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.

3.6 Packet Level entity

The concept of communication via logical channels is native to Packet Level 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 Level 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 Level entity in a DTE.

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

3.7 Basic structure of packets

Each packet transferred across the DTE/DXE interface consists of at least 3 octets. These three octets contain a General Format Identifier, a Logical Channel Identifier, and a Packet Type Identifier. Other packet fields are appended as required (see clause 12). Figure 3 shows the generalized packet format.

For interoperability across all DTE/DXE interfaces, it is required that any additional field appended after the first 3 octets contain an integral number of octets. Receipt of a packet with a nonoctet-aligned

field is considered an error. If the Link Level does not provide error recovery for nonoctet-aligned packets, then appropriate error procedures for format errors, depending on the packet type, should be invoked at the Packet Level.

Each packet to be transferred across the DTE/DXE interface is contained within the Link Level Information Field that will delimit its length. Exactly one packet is contained in the Information Field.

Packet types and their use with various services are given in table 1.

Table 1 — Packet Groupings/Functions

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

* VC = Virtual Call

PVC = Permanent Virtual Circuit

3.8 Packet Level state diagrams and tables

The following figures further supplement the procedural definition of the Packet Level:

- a) Figure 4, which presents state diagrams of the transitions of the Packet Level under normal operation; and
- b) Figure 5, which presents the actions taken by a DTE on receipt of any packet in any state of Packet Level operation.

3.9 List of system parameters

The system parameters are presented in figure 6. Values for these parameters may be chosen independently of the specific values chosen by the interfacing DXE. They may take into account whether the Packet Level entity interfaces with a network (and, therefore, the characteristics of the network) or with a Packet Level entity of another DTE, the nature of the traffic flowing over the interface, and other appropriate considerations. The values chosen may apply in common to all logical channels in the Packet Level entity.

The system parameters fall into two classes:

- a) timer parameters, defined in figure 6A; and
- b) retransmission-count parameters, defined in figure 6B.

3.10 Procedures for initialization

Initialization of the Packet Level corresponds to initialization of each logical channel in the Packet Level entity. Prior to initial data transmission on any logical channel, the initialization procedure for the Link Level shall be completed. Then the DTE shall initiate the restart procedure.

See also:

- Restart Procedures (clause 4)

4 Procedures for Restart

The restart procedure is used to initialize or reinitialize the Packet Level 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 Level 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).

There are three states of a logical channel in relation to the restart procedure. As shown in figure 4B, they are the PACKET LEVEL 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 LEVEL READY state (r1)).

Figure 5C specifies 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 level 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 Level 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 23);
- Restart Request Response Timer (T20) (figure 6A);
- Restart Request Retransmission Count (R20) (figure 6B);
- Receiving a Restart Indication (4.2);
- Restart Collision (4.3);

- Restart Confirmation (4.4):
- Packet Level 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 level entity.

NOTE — In a DTE/DTE environment, the RESTART INDICATION packet received by one 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 23);
- Restarting cause (12.6.1).
- Restart Collision (4.3);
- Restart Confirmation (4.4);
- Timers to consider when receiving a RESTART INDICATION packet (figure 6C).

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 24).

4.5 Determining "DTE" or "DCE" characteristics

This sub-clause describes how 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 Level, 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 — 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 discussed above are not needed. In these cases, the DTE may be initialized to act in the appropriate manner.

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).

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.)

Figures 7 and 8 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 4C. Figure 5D specifies actions taken by the DTE on the receipt of packets from the DXE as applied to the Virtual Call setup and clearing procedures.

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 level entity to be sent to the remote DTE.

NOTES

- 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.
- 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.
- 3 Sub-clause 4.5 presents procedures for determining how a DTE chooses a logical channel in the READY state (p1) when originating a Virtual Call. 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 Level 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) (figure 6A);

- CALL REQUEST packet format (12.2.1 and figure 11);
- 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 shall be forwarded to a higher level entity. In addition, optional user facility information may also be passed to a higher level entity.

NOTES

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

See also:

- INCOMING CALL packet format (12.2.1 and figure 11);
- 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 (figure 6C).

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.

5.2 Procedures for Virtual Call setup

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 level entity before a CALL ACCEPTED packet may be returned by the Packet Level. 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. However, a call may be rejected, without informing a higher level entity of its receipt, for reasons local to the Packet Level (for example, a format error in the INCOMING CALL packet).

NOTE — A CALL ACCEPTED packet may not be returned if the INCOMING CALL packet indicates the Fast Select Facility with a restriction on the response.

See also:

- CALL ACCEPTED packet format (12.2.2 and figure 12);
- 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 shall be forwarded to a higher level entity. In addition, optional user facility information may also be passed to a higher level entity.

NOTE — In a DTE/DTE environment, the CALL CONNECTED packet received by one 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 (12.2.2 and figure 12);
- 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 should 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.*

5.3 Rejecting a call

The previous sub-clauses 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 level 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 level entity or the expiration of timer T21.

As noted previously, timer T21 shall be 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) (figure 6A)
- 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 level 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 Level 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 level 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.

NOTE — A DTE that aborts its own call after transmitting a CALL REQUEST packet and before receiving a response may not transmit data in the CLEAR REQUEST packet.

See also:

- CLEAR REQUEST packet format (12.2.3 and figure 13);
- Clear Request Response Timer (T23) (figure 6A);
- Clear Request Retransmission Count (R23) (figure 6B);
- 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 in 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 level entity. Any data and optional user facility information received in the CLEAR INDICATION packet shall also be forwarded to a higher level entity.

NOTE — In a DTE/DTE environment, the CLEAR INDICATION packet received by one 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 (12.2.3 and figure 13);
- Clearing cause (12.2.3);

- Clear Collision (5.5.3);
- Clear Confirmation (5.5.4);
- Timers to consider when receiving a CLEAR INDICATION packet (figure 6C).

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 (12.2.4 and figure 15).

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 16);
- INTERRUPT packet format (12.3.2 and figure 17);
- 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 level 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 3.7).

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 will invoke the 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 should set 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.

NOTES

1 The use of the D-bit procedure does not obviate the need for a higher level 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.

2 The setting of the D-bit is determined from instructions received from a higher level 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 should 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 it is set to 1 in a full DATA packet or in a partially full DATA packet also carrying the D-bit set to 1, it indicates that more data is to follow. *Recombination 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 level entities. Such sequences are known as M-bit sequences. Figure 10 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 should 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 should 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 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 10 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 sub-clause.)

The remainder of this sub-clause 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.

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	
Category	M	D	Full		M	D
B	0 or 1	0	No	No	0 (see Note 1)	0
B	0	1	No	No	0	1
B	1	1	No	No	1	1
B	0	0	Yes	No	0	0
B	0	1	Yes	No	0	1
A	1	0	Yes	Yes (see Note 2)	1	0
B	1	1	Yes	No	1	1

* 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.

NOTES

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

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

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 10).

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 CCITT 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 should 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 level entity. Likewise, the setting of the Q-bit for each complete packet sequence received is passed to a higher level 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 of 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. The action by a DTE when the Q-bit is not set to the same value in all DATA packets received in a complete packet sequence is to 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 10);
- Numbering of packets (7.1.1);
- Reset Procedures (clause 8).

6.7 Fragmentation and reassembly of messages

The Packet Level provides the service of transmitting messages (also referred to as M-bit sequences) between peer higher level entities. In a source DTE, the Packet Level 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 Level reassembles the User Data Fields of DATA packets into a message. The message is passed to a higher level entity with an indication of the length and Q-bit setting of each complete packet sequence, and an indication of whether the higher level 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 10);
- Complete Packet Sequences (6.5 and figure 10);
- 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 level entity. Upon receipt of an INTERRUPT packet, a signal indicating that an interrupt has occurred, along with the data, is passed to a higher level entity.

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 4E. Figure 5F 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 will 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 level 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 17);
- Interrupt Response Timer (T26) (figure 6A);
- 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."

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

See also:

- Reset Procedures (clause 8);
- Interrupt Confirmation (6.8.3);
- Timers to consider when receiving an INTERRUPT packet (figure 6C).

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 18).

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.

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 (13.28).

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 4F. Figure 5G 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 9 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 (figure 6C)

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. Alternatively, the Extended Packet Sequence Numbering Facility may be provided at the DTE/DXE interface. In this case, 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 Level 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 $P(R)$ shall 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. Otherwise, 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 Level 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.

NOTES

1 To achieve a greater degree of reliability, DTEs may use the D-bit procedure to signify receipt of data by a higher level entity. Such use requires prior agreement between the two DTEs. When using this procedure, the sending Packet Level 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 level entity is desired. On receiving the last DATA packet of an M-bit sequence with the D-bit set to 1, the Packet Level must not return the corresponding P(R) until the data in this packet has been acknowledged by a higher level entity. When this acknowledgement is received, the Packet Level should 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.*

2 When using the procedure mentioned in Note 1, it is for further study whether the Packet Level need wait for acknowledgement by a higher level entity of the 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.

3 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 should reset the logical channel with a cause indicating "DTE Originated" and the diagnostic "D-bit Procedure Not Supported."

4 *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.*

5 *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.*

6 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 that it is ready to receive the W DATA packets within the window starting with P(R), where P(R) is indicated in the RR packet.

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 19).

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 by 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.

NOTES

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.

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 20);
- RECEIVE READY packet (7.1.5);
- Reset Procedures (clause 8).

7.2 Throughput characteristics and throughput classes

The attainable throughput on Virtual Calls and Permanent Virtual Circuits carried at the DTE/DXE interface may vary due to the statistical sharing of transmission and switching resources and is constrained by:

- a) the access line characteristics, local window size, and traffic characteristics of other logical channels at the local DTE/DXE interface;
- b) the access line characteristics, local window size, and traffic characteristics of other logical channels at the remote DTE/DCE interface; and
- c) the throughput achievable on the Virtual Call or Permanent Virtual Circuit through the network(s) independent of interface characteristics including number of active logical channels. This throughput may be

7.2 Throughput characteristics and throughput classes

dependent on network service characteristics such as window rotation mechanisms and/or optional user facilities requested on national/international calls.

The attainable throughput will also be affected by:

- a) the receiving DTE flow controlling the interfacing DXE;
- b) the transmitting DTE not sending DATA packets which have the maximum User Data Field length;
- c) the local DTE/DXE window and/or packet sizes; and
- d) the use of the D-bit.

A throughput class for one direction of transmission is an inherent characteristic of the Virtual Call or Permanent Virtual Circuit related to the amount of resources allocated to this Virtual Call or Permanent Virtual Circuit. This characteristic is meaningful when the D-bit is set to 0 in DATA packets. It is a measure of the throughput that is not normally exceeded on the Virtual Call or Permanent Virtual Circuit. However, due to the statistical sharing of transmission and switching resources, it is not guaranteed that the throughput class can be reached 100% of the time.

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

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

- a) *the access data links of both ends of a Virtual Call or Permanent Virtual Circuit are engineered for the throughput class;*
- b) the receiving DTE is not flow controlling the interfacing DXE such that the throughput class is not attainable;
- c) the transmitting DTE is sending DATA packets which have the maximum User Data Field length; and
- d) all DATA Packets transmitted on the Virtual Call or Permanent Virtual Circuit have the D-bit set to 0.

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

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 data signalling 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 the Throughput Class Negotiation Facility has been subscribed to.

NOTE — The summation of throughput classes for all Virtual Call and Permanent Virtual Circuit logical channels supported at a DTE/DXE interface may be greater than the data transmission rate of the access line.

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 Facility 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. When 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 level 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 and INTERRUPT packets that may be in the network associated with that logical channel.

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 4D. 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.

Figure 5E 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 (figure 6A);
- Retransmission Parameters (figure 6B).

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 level 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 Level 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 Level 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 21);
- Reset Request Response Timer (T22) (figure 6A);
- Reset Request Retransmission Count (R22) (figure 6B);
- 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 level entity.

NOTE — In a DTE/DTE environment, the RESET INDICATION packet received by one 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 21);
- Resetting Cause (12.5.1);
- Reset Collision (8.3);
- Reset Confirmation (8.4);
- Timers to consider when receiving a RESET INDICATION packet (figure 6C).

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 22).

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 Levels 1 and 2 on the Packet Level

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

A failure on Levels 1 and/or 2 is defined as a condition in which frames cannot be transmitted or cannot be received across the DTE/DXE interface because of abnormal conditions caused, for instance, by

- a) a line fault between the DTE and DXE; or
- b) the transmission by the DTE or receipt from the DXE of a Link Level DISC command in the case of a single link procedure.

When such a failure 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 failure, 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 failure 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.*

NOTE — In a DTE/DTE environment using multilink operation at Levels 1 and 2, a Level 1 and/or 2 failure in the above discussion is intended to denote a failure of the entire multilink group.

See also:

- Clearing Procedures (5.5);
- Reset Procedures (clause 8);

— Restart Procedures (clause 4).

11 Error handling

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

- a) syntactical errors — receipt of a packet that does not conform to the format specifications of the Packet Level; 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. Figure 5 summarizes the actions a DTE follows upon detection of a syntactical or logical error. Figure 6 summarizes 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 figures 5 and 6). The DIAGNOSTIC packet supplies information on error situations which are considered unrecoverable at the Packet Level. Upon receipt of a DIAGNOSTIC packet, the Packet Level passes an indication of its receipt and the

associated error information to a higher level 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 25);
- Diagnostic Codes (figure 14);
- Reset Procedures (clause 8);
- Clearing Procedures (5.5);
- Restart Procedures (clause 4).

11.2 Nonreceipt of window-rotation information

The procedures described in this clause 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 level 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 Level. 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.

NOTES

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

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 — 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) (figure 6A);
- Data Packet Retransmission Count (R25) (figure 6B);
- Reset Procedures (clause 8).

11.2.2 Optional procedures at the receiving DTE

To decrease the probability of a lost window-rotation indication packet, the DTE may send a RR, RNR, DATA, or REJECT (if subscribed to) packet every T24 time units (i.e., at the expiration of the Window Status Transmission Timer) while the logical channel is in the FLOW CONTROL READY state (d1). If T24 time units have elapsed since the last transmission of a window-rotation indication packet, then either an RR or an RNR packet is sent. The packet that is sent should reflect the current condition of the DTE that transmits it. Thus, if the DTE is unable to accept more DATA packets, then an RNR packet is transmitted; otherwise, an RR packet is transmitted. These packets contain a P(R) corresponding to the most recently-received correct DATA packet. This P(R) then becomes the lower window edge at the transmitting DTE.

The above procedure does not preclude the use of additional algorithms for rotation of the window. This procedure merely attempts to ensure that once a decision is made to rotate the window, the transmission of that decision will be effected even if the original packet is lost.

NOTE — In a DTE/DCE environment, use of the above procedure at one DTE/DCE interface may not have any effect on the other DTE/DCE interface.

See also:

- Window Status Transmission Timer (T24) (figure 6A).

11.3 Receipt of erroneous DATA packets

The normal operation of data transfer requires that DATA packets be received in sequence, be no larger than the maximum-allowed packet size for the current data transfer operation, and contain an integral number of octets in the User Data Field. Receipt of a DATA packet with a nonconsecutive P(S) value (i.e., $P(S) \neq \text{last } P(S) + 1, \text{ modulo } 8$, or modulo 128 when extended), with a User Data Field length greater than the allowed maximum, or with a User Data Field not octet aligned is considered an error.

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Three alternatives are available to a DTE for recovering from the errors described above. They are:

- a) ignore the erroneous DATA packet and reset the logical channel with a cause indicating "DTE Originated" and one of the following diagnostics as appropriate:

- Invalid P(S),
- Packet Too Long, or
- Nonoctet Aligned Data Field;

- b) ignore the erroneous DATA packet and transmit a REJECT packet with a P(R) equal to the P(S) expected in the next in-sequence DATA packet.

This alternative may be used only if agreement has been reached on the use of the Packet Retransmission Facility with the interfacing DXE. Furthermore, in a DTE/DCE environment, packet retransmission by a DCE as a result of receiving a REJECT packet only carries local significance. That is, a DCE will respond to the REJECT packet by retransmitting the requested DATA packet across the local interface (a DCE does not transmit a REJECT packet to the remote DTE).

- c) ignore the erroneous DATA packet and all subsequent DATA packets until the correct DATA packet is received. This procedure depends on the source DTE retransmitting all DATA packets still in the window after its timer T25 has expired up to a maximum of R25 retransmissions. (After this, the source DTE should reset the logical channel with a cause indicating "DTE Originated" and the diagnostic "Timer Expired Or Retransmission Count Surpassed For DATA Packet Transmission.")

In a DTE/DCE environment, the DCE will reset the logical channel if it receives a duplicate DATA packet. This alternative requires that both DTEs have agreed to this method for recovering from erroneous DATA packets.

The standard mode of recovery requires that the logical channel be reset.

See also:

- Reset Procedures (clause 8);

- Optional User Facility for Packet Retransmission (13.4);
- Window Rotation Timer (T25) (11.2.1 and figure 6A);
- Data Packet Retransmission Count (R25) (11.2.1 and figure 6B);
- Flow Control Principles (7.1.3).

12 Packet formats

The information contained in this clause includes:

- a) general packet-format information (12.1);
- b) formats of the Call Setup and Call Clearing packets (12.2);
- c) formats of the DATA and Interrupt packets (12.3);
- d) formats of the Flow Control packets (12.4);
- e) formats of the Reset packets (12.5);
- f) formats of the Restart packets (12.6);
- g) format of the DIAGNOSTIC packet (12.7);
- h) format of the REJECT packet (12.8); and
- i) formats of the Registration packets (12.9).

12.1 General

A packet always consists of at least three octets. These three octets contain the General Format Identifier Field, the Logical Channel Identifier Field, and the Packet Type Identifier Field. Depending on the particular packet type, other fields may also be defined. Figure 3 shows the generalized packet format.

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

NOTE — Any such field:

- a) would only be provided as an addition following all previously defined fields and not as an insertion between any of the previously defined fields;
- b) would be transmitted to a DTE only when either the interfacing DXE has been informed that the receiving DTE is able to interpret this field and act upon it, or when the receiving DTE can ignore the field without adversely affecting the operation of the DTE/DXE interface (including charging); and

- c) would not contain any information pertaining to a user facility to which the DTE has not subscribed, unless the DTE can ignore the facility without adversely affecting the operation of the DTE/DXE interface (including charging).

Bits of an octet are numbered 8 to 1, where bit 1 is the low-order bit and is transmitted first. Octets of a packet are consecutively numbered starting from 1 and are transmitted in this order.

12.1.1 General Format Identifier field

The General Format Identifier Field is a four-bit, binary-coded field which is provided to indicate the general format of the rest of the header. The General Format Identifier Field is located in bit positions 8, 7, 6, and 5 of octet 1, where bit 5 is the low-order bit (see table 3).

Bit 8 of the General Format Identifier is used for the Qualifier bit (Q-bit) bit in DATA packets. It is set to 0 in all other packets.

Bit 7 of the General Format Identifier is used for the delivery confirmation procedure in DATA packets and call setup packets. It is set to 0 in all other packets.

Bits 6 and 5 are encoded for four possible indications. Two of the codes are used to distinguish packets using modulo 8 sequence numbering from packets using modulo 128 sequence numbering. The third code is used to indicate an extension to an expanded format for a family of General Format Identifier codes which are a subject of further study in CCITT. The fourth code is reserved for other applications.

Table 3 — General format identifier

		OCTET 1 BITS: 8 7 6 5
Sequence numbering scheme modulo 8	Call Setup packets	0 X 0 1
	Call Clearing, Flow Control, Interrupt, REJECT, Reset, Restart, Registration, and DIAGNOSTIC packets	0 0 0 1
	DATA packets	X X 0 1
Sequence numbering scheme modulo 128	Call Setup packets	0 X 1 0
	Call Clearing, Flow Control, Interrupt, REJECT, Reset, Restart, Registration, and DIAGNOSTIC packets	0 0 1 0
	DATA packets	X X 1 0
General Format Identifier extension		0 0 1 1
Reserved for other applications		• • 0 0

* Undefined

NOTE — A bit which is indicated as "X" may be set to either "0" or "1", as discussed in subsequent clauses.

NOTES

1 The DTE must encode bits 6 and 5 of the General Format Identifier to be consistent with whether it has subscribed to the Extended Packet Sequence Numbering Facility (i.e., whether it uses modulo 128 sequence numbering).

2 It is envisioned that other General Format Identifier codes could identify alternative packet formats.

See also:

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

12.1.2 Logical Channel Identifier field

The Logical Channel Identifier Field¹⁾ appears in every packet in bit positions 4, 3, 2, and 1 of octet 1 and all bit positions of octet 2. This field is binary-coded using bit positions 4 through 1 of octet 1 followed by bit positions 8 through 1 of octet 2. Bit 1 of octet 2 is the low-order bit.

For each logical channel, this number has local significance in a DTE/DCE environment.

In Restart, DIAGNOSTIC, and Registration packets, this field is coded with all zeros.

12.1.3 Packet Type Identifier field

Each packet shall be identified in octet 3 according to table 4.

12.2 Call Setup and Call Clearing packets

The packets described in this clause are used for setting up and clearing a Virtual Call. They include the following packets:

- a) CALL REQUEST and INCOMING CALL (12.2.1);
- b) CALL ACCEPTED and CALL CONNECTED (12.2.2);
- c) CLEAR REQUEST and CLEAR INDICATION (12.2.3); and
- d) CLEAR CONFIRMATION (12.2.4).

¹⁾ The Logical Channel Identifier Field can alternatively be viewed as consisting of two subfields: a Logical Channel Group Number Field and a Logical Channel Number Field. The Logical Channel Group Number Field is in bit positions 4, 3, 2, and 1 of octet 1. The Logical Channel Number Field is in all bit positions of octet 2. Both subfields are binary-coded, where bit 1 is the low-order bit. This alternative terminology will not be used within this International Standard.

See also:

- Procedures for setting up and clearing Virtual Calls (clause 5).

12.2.1 CALL REQUEST and INCOMING CALL packets

Figure 11 illustrates the format of CALL REQUEST and INCOMING CALL packets.

In a DTE/DCE environment, the CALL REQUEST packet and INCOMING CALL packet are two different "physical" packets because of the intervening network. However, in a DTE/DTE environment, the CALL REQUEST packet sent by one DTE is the same as the INCOMING CALL packet received by the other DTE.

12.2.1.1 Basic format

The first three octets consist of the General Format Identifier, the Logical Channel Identifier, and the Packet Type Identifier Fields, as described in 12.1.1 through 12.1.3. However, bit 7 of octet 1 (part of the General Format Identifier) is set as noted below.

12.2.1.1.1 General Format Identifier

Bit 7 of the General Format Identifier (octet 1) is set to 0 or 1 depending on whether the mechanism described in 6.3 is used (this mechanism is used to express the possible use of end-to-end data acknowledgement during the data-transfer phase).

12.2.1.1.2 Address Length fields

Octet 4 consists of field-length indicators for the calling- and called-DTE addresses. Bits 8, 7, 6, and 5 indicate the length of the calling-DTE address in semi-octets. Bits 4, 3, 2, and 1 indicate the length of the called-DTE address in semi-octets. Each address-length indicator is binary-coded, where bit 5 or 1 is the low-order bit of the indicator.

12.2.1.1.3 Address field

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

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

Starting from the high-order digit, the address is coded in octet 5 and consecutive octets, with two digits per octet. In each octet, the higher-order digit is coded in bits 8, 7, 6, and 5.

Table 4 — Packet type Identifier

PACKET TYPE		OCTET 3 BITS:
FROM DTE TO DXE	FROM DXE TO DTE	8 7 6 5 4 3 2 1
Call Setup and Call Clearing		
CALL REQUEST	INCOMING CALL	0 0 0 0 1 0 1 1
CALL ACCEPTED	CALL CONNECTED	0 0 0 0 1 1 1 1
CLEAR REQUEST	CLEAR INDICATION	0 0 0 1 0 0 1 1
CLEAR CONFIRMATION	CLEAR CONFIRMATION	0 0 0 1 0 1 1 1
Data and Interrupt		
DATA	DATA	X X X X X X X 0
INTERRUPT	INTERRUPT	0 0 1 0 0 0 1 1
INTERRUPT CONFIRMATION	INTERRUPT CONFIRMATION	0 0 1 0 0 1 1 1
Flow Control and Reset		
RECEIVE READY	RECEIVE READY	
modulo 8	modulo 8	X X X 0 0 0 0 1
modulo 128 ¹	modulo 128 ¹	0 0 0 0 0 0 0 1
RECEIVE NOT READY	RECEIVE NOT READY	
modulo 8	modulo 8	X X X 0 0 1 0 1
modulo 128 ¹	modulo 128 ¹	0 0 0 0 0 1 0 1
REJECT ²	REJECT ³	
modulo 8	modulo 8	X X X 0 1 0 0 1
modulo 128 ¹	modulo 128 ¹	0 0 0 0 1 0 0 1
RESET REQUEST	RESET INDICATION	0 0 0 1 1 0 1 1
RESET CONFIRMATION	RESET CONFIRMATION	0 0 0 1 1 1 1 1
Restart		
RESTART REQUEST	RESTART INDICATION	1 1 1 1 1 0 1 1
RESTART CONFIRMATION	RESTART CONFIRMATION	1 1 1 1 1 1 1 1
Diagnostic		
DIAGNOSTIC ⁴	DIAGNOSTIC ⁵	1 1 1 1 0 0 0 1
Registration⁶		
REGISTRATION REQUEST	REGISTRATION REQUEST ⁷	1 1 1 1 0 0 1 1
REGISTRATION CONFIRMATION ⁸	REGISTRATION CONFIRMATION	1 1 1 1 0 1 1 1

NOTES

- 1 Modulo 128 numbering is used only with the Extended Packet Sequence Numbering Facility.
- 2 A DTE may transmit a REJECT packet only if the optional Packet Retransmission Facility has been subscribed to for transmission of REJECT packets from DTE to DXE (see 13.4)
- 3 A DCE will never transmit a REJECT packet and, therefore, a DTE need not be able to process a received REJECT packet in a DTE/DCE environment. On the other hand, a DTE must be able to process a received REJECT packet in a DTE/DTE environment only if the agreement to use the optional Packet Retransmission Facility includes retransmission of DATA packets by the DTE.
- 4 A DTE may transmit a DIAGNOSTIC packet only in DTE/DTE environment and only if it can be set to suppress its generation when connected to a network.
- 5 In a DTE/DCE environment, a DTE may receive a DIAGNOSTIC packet from a DCE if implemented by the network. In a DTE/DTE environment, a DTE may receive a DIAGNOSTIC packet from a DTE only if the transmitting DTE can be set to suppress its generation when connected to a network.
- 6 Registration packets are used only if the optional On-line Facility Registration Facility has been subscribed to (see 13.1).
- 7 A DCE will never transmit a REGISTRATION REQUEST packet and, therefore, a DTE need not be able to process a received REGISTRATION REQUEST packet in a DTE/DCE environment. On the other hand, a DTE must be able to process a received REGISTRATION REQUEST packet in a DTE/DTE environment only if the agreement to use the optional On-line Facility Registration Facility includes the DTE responding to registration-procedure initiation.
- 8 A DTE may not transmit a REGISTRATION CONFIRMATION packet in a DTE/DCE environment. On the other hand, a DTE must be able to transmit a REGISTRATION CONFIRMATION packet in response to a REGISTRATION REQUEST packet only if the agreement to use the optional On-line Facility Registration Facility includes the DTE responding to registration-procedure initiation.

NOTE — A bit which is indicated as "X" may be set to either "0" or "1", as discussed in subsequent clauses.

When necessary, the Address Field shall be rounded up to an integral number of octets by inserting zeros in bits 4, 3, 2, and 1 of the last octet of the field.

NOTE — This field may be used for optional addressing facilities such as abbreviated addressing. The optional addressing facilities employed, as well as the coding of those facilities, are for further study by CCITT.

12.2.1.1.4 Facility Length field

The octet following the Address Field indicates the length of the Facility Field in octets. The facility-length indicator is binary-coded, where bit 1 is the low-order bit of the indicator.

12.2.1.1.5 Facility field

The Facility Field is present only when the DTE or DXE is using an optional user facility requiring some indication in the CALL REQUEST packet or INCOMING CALL packet.

The Facility Field contains an integral number of octets. The actual maximum length of this field depends on the facilities that are supported at the DTE/DXE interface. However, this maximum cannot exceed 109 octets.

See also:

— Coding of the Facility Field (clause 15).

12.2.1.1.6 Call User Data field

Following the Facility Field, the Call User Data Field may be present and has a maximum length of 16 octets. This field shall contain an integral number of octets, as indicated in 3.7.

When a Virtual Call is being established between two packet-mode DTEs, networks do not act on any part of the Call User Data Field (see CCITT Recommendation X.244).

12.2.1.2 Extended format

The extended format may be used only in conjunction with the Fast Select Facility (see 13.16). The extended format is identical to the basic format except that the Call User Data Field has a maximum length of 128 octets.

12.2.2 CALL ACCEPTED and CALL CONNECTED packets

Figure 12 illustrates the format of CALL ACCEPTED and CALL CONNECTED packets.

In a DTE/DCE environment, the CALL ACCEPTED packet and CALL CONNECTED packet are two different "physical" packets because of the intervening network. However, in a DTE/DTE environment, the CALL ACCEPTED packet sent by one DTE is the same as the CALL CONNECTED packet received by the other DTE.

12.2.2.1 Basic format

The first three octets consist of the General Format Identifier, the Logical Channel Identifier, and the Packet Type Identifier Fields, as described in 12.1.1 through 12.1.3. However, bit 7 of octet 1 (part of the General Format Identifier) is set as noted below.

12.2.2.1.1 General Format Identifier

Bit 7 of the General Format Identifier (octet 1) is set to 0 or 1 depending on whether the mechanism described in 6.3 is used (this mechanism is used to express the possible use of end-to-end data acknowledgement during the data-transfer phase).

12.2.2.1.2 Address Length fields

Octet 4 consists of field-length indicators for the calling- and called-DTE addresses. Bits 8, 7, 6, and 5 indicate the length of the calling-DTE address in semi-octets. Bits 4, 3, 2, and 1 indicate the length of the called-DTE address in semi-octets. Each address-length indicator is binary-coded, where bit 5 or 1 is the low-order bit of the indicator.

The use of the Address Length Fields in CALL ACCEPTED packets is mandatory, even if they are set to zero.

12.2.2.1.3 Address field

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

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

Starting from the high-order digit, the address is coded in octet 5 and consecutive octets with two digits per octet. In each octet, the higher-order digit is coded in bits 8, 7, 6, and 5.

When necessary, the Address Field shall be rounded up to an integral number of octets by inserting zeros in bits 4, 3, 2, and 1 of the last octet of the field.

NOTE — This field may be used for optional addressing facilities such as abbreviated addressing. The optional addressing facilities employed, as well as the coding of those facilities, are for further study by CCITT.

12.2.2.1.4 Facility Length field

The octet following the Address Field indicates the length of the Facility Field in octets. The facility-length indicator is binary-coded, where bit 1 is the low-order bit of the indicator.

The use of the Facility Length Field in CALL ACCEPTED packets is mandatory, even if it is set to zero.

12.2.2.1.5 Facility field

The Facility Field is present only when the DTE or DXE is using an optional user facility requiring some indication in the CALL ACCEPTED packet or CALL CONNECTED packet.

The Facility Field contains an integral number of octets. The actual maximum length of this field depends on the facilities that are supported at the DTE/DXE interface. However, this maximum cannot exceed 109 octets.

See also:

— Coding of the Facility Field (clause 15).

12.2.2.2 Extended format

The extended format may be used only in conjunction with the Fast Select Facility (see 13.16). The extended format is identical to the basic format except that the Called User Data Field may be present.

Called User Data field:

Following the Facility Field, the Called User Data Field may be present and has a maximum length of 128 octets. This field shall contain an integral number of octets, as indicated in 3.7.

When a Virtual Call is being established between two packet-mode DTEs, networks do not act on any part of the Called User Data Field (see CCITT Recommendation X.244).

12.2.3 CLEAR REQUEST and CLEAR INDICATION packets

Figure 13 illustrates the format of CLEAR REQUEST and CLEAR INDICATION packets.

In a DTE/DCE environment, the CLEAR REQUEST packet and CLEAR INDICATION packet are two different "physical" packets because of the intervening network. However, in a DTE/DTE environment, the CLEAR REQUEST packet sent by one DTE is the same as the CLEAR INDICATION packet received by the other DTE.

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12.2.3.1 Basic format

The first three octets consist of the General Format Identifier, the Logical Channel Identifier, and the Packet Type Identifier Fields, as described in 12.1.1 through 12.1.3.

12.2.3.1.1 Clearing Cause field

Octet 4 is the Clearing Cause Field and contains the reason for the clearing of the call.

The Clearing Cause Field in a CLEAR REQUEST shall be set to "DTE Originated" by a DTE.

The coding of the Clearing Cause Field in a CLEAR INDICATION packet is given in table 5 (the definition of each clearing cause is given in CCITT Recommendation X.96). *In a DTE/DCE environment, a DTE, in order to allow for possible later extensions to table 5, shall be able to accept any value in the Clearing Cause Field in a CLEAR INDICATION packet. In a DTE/DTE environment, a DTE may either handle a clearing cause other than "DTE Originated" as it does in a DTE/DCE environment (i.e., process the packet normally) or treat it as an error. In the latter case, the Packet Level transmits a CLEAR REQUEST packet with a cause indicating "DTE Originated" and the diagnostic "Improper Cause Code From DTE."*

12.2.3.1.2 Diagnostic Code field

Octet 5 is the Diagnostic Code Field and contains additional information on the reason for the clearing of the call. The coding of the Diagnostic Code Field is dependent on the clearing cause as given in figure 14A.

In a CLEAR REQUEST packet, the Diagnostic Code Field is required, even if it indicates no additional information.

In a CLEAR INDICATION packet, if the Clearing Cause Field indicates "DTE Originated," the Diagnostic Code Field has been passed unchanged from the remote DTE as a result of its having initiated a clearing procedure *or, in a DTE/DCE environment, a restarting procedure. In a CLEAR INDICATION packet, if the Clearing Cause Field does not indicate "DTE Originated," the Diagnostic Code Field is network generated.*

NOTE — The contents of the Diagnostic Code Field do not alter the meaning of the Clearing Cause Field. A DTE is not required to undertake any action on the contents of the Diagnostic Code Field. The Clearing Cause Field has to be accepted even if the Diagnostic Code Field contains an unspecified code combination.

12.2.3.2 Extended format

The extended format is used only when the DTE or DXE needs to use the Address Field, the Facility Field, and/or the Clear User Data Field. The Address and Facility Fields are used in a CLEAR REQUEST or CLEAR INDICATION packet in response to an INCOMING CALL or CALL REQUEST packet, respectively, when the Called Line Address Modified Notification Facility (see 13.26) is present. The Facility Field is used when the Charging Information Facility (see 13.22) is present. The Clear User Data Field is used in conjunction with the Fast Select Facility (see 13.16).

The description in 12.2.3.1 applies to the extended format and, in addition, the following fields follow the Diagnostic Code Field.

12.2.3.2.1 Address Length fields

Octet 6 consists of field-length indicators for the calling- and called-DTE addresses. Bits 8, 7, 6, and 5 indicate the length of the calling-DTE address in semi-octets. Bits 4, 3, 2, and 1 indicate the length of the called-DTE address in semi-octets. Each address-length indicator is binary-coded, where bit 5 or 1 is the low-order bit of the indicator.

12.2.3.2.2 Address field

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

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

Starting from the high-order digit, the address is coded in octet 5 and consecutive octets with two digits per octet. In each octet, the higher-order digit is coded in bits 8, 7, 6, and 5.

When necessary, the Address Field shall be rounded up to an integral number of octets by inserting zeros in bits 4, 3, 2, and 1 of the last octet of the field.

12.2.3.2.3 Facility Length field

The octet following the Address Field indicates the length of the Facility Field in octets. The facility-length indicator is binary-coded, where bit 1 is the low-order bit of the indicator.

Table 5 — Coding of the clearing cause field in clear indication packets

	OCTET 4 BITS: 8 7 6 5 4 3 2 1	NOTES
DTE Originated	0 0 0 0 0 0 0 0	1
DTE Originated	1 0 0 0 0 0 0 0	2
Number Busy	X 0 0 0 0 0 0 1	3,4
Out Of Order	X 0 0 0 1 0 0 1	3,4
Remote Procedure Error	X 0 0 1 0 0 0 1	3,4
Reverse Charging Acceptance Not Subscribed	X 0 0 1 1 0 0 1	3,4,5
Incompatible Destination	X 0 1 0 0 0 0 1	3,4
Fast Select Acceptance Not Subscribed	X 0 1 0 1 0 0 1	3,4,5
Ship Absent	X 0 1 1 1 0 0 1	3,4,6
Invalid Facility Request	X 0 0 0 0 0 1 1	3,4
Access Barred	X 0 0 0 1 0 1 1	3,4
Local Procedure Error	X 0 0 1 0 0 1 1	3,4
Network Congestion	X 0 0 0 0 1 0 1	3,4
Not Obtainable	X 0 0 0 1 1 0 1	3,4
RPOA Out Of Order	X 0 0 1 0 1 0 1	3,4,5
Gateway-detected Procedure Error	1 1 0 0 0 0 0 1	3
Gateway Congestion	1 1 0 0 0 0 1 1	3

NOTES

- 1 Used when the Diagnostic Code Field is coded in accordance with figure 14B.
- 2 Used when the Diagnostic Code Field is not coded in accordance with figure 14B.
- 3 These clearing causes apply only to a DTE/DCE environment.
- 4 The bit indicated as "X" set to 0 indicates a clearing cause generated by a public data network and set to 1 indicates a clearing cause generated by a private network.
- 5 May be received only if the corresponding optional user facility is used.
- 6 Used in conjunction with maritime mobile service.

12.2.3.2.4 Facility field

The Facility Field is present only when the DTE or DXE is using an optional user facility requiring some indication in the CLEAR REQUEST or CLEAR INDICATION packet.

The Facility Field contains an integral number of octets. The actual maximum length of this field depends on the facilities that are supported at the DTE/DXE interface. However, this maximum cannot exceed 109 octets.

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See also:

- Coding of the Facility Field (clause 15)

12.2.3.2.5 Clear User Data field

Following the Facility Field, the Clear User Data Field may be present. This field has a maximum length of 128 octets. This field shall contain an integral number of octets, as indicated in 3.7.

When a Virtual Call is being cleared between two packet-mode DTEs, networks do not act on any part of the Clear User Data Field (see CCITT Recommendation X.244).

12.2.4 CLEAR CONFIRMATION packet

Figure 15 illustrates the format of the CLEAR CONFIRMATION packet transmitted by a DTE as well as the format of the CLEAR CONFIRMATION packet received by a DTE.

12.2.4.1 Basic format

This packet contains three octets. These octets consist of the General Format Identifier, the Logical Channel Identifier, and the Packet Type Identifier Fields, as described in 12.1.1 through 12.1.3.

12.2.4.2 Extended format

The extended format is used for CLEAR CONFIRMATION packets issued by a DCE only in conjunction with the Charging Information Facility described in 13.22. It is not used for CLEAR CONFIRMATION packets issued by a DTE.

The description in 12.2.4.1 applies to the extended format and, in addition, the following fields follow octet 3.

12.2.4.2.1 Address Length fields

Octet 4 consists of field-length indicators for the called- and calling-DTE addresses. Bits 8, 7, 6, and 5 indicate the length of the calling-DTE address in semi-octets. Bits 4, 3, 2, and 1 indicate the length of the called-DTE address in semi-octets. Each address-length indicator is binary-coded, where bit 5 or 1 is the low-order bit of the indicator.

Presently, these fields are coded with all zeros.

12.2.4.2.2 Address field

This field is not present.

12.2.4.2.3 Facility Length field

The octet following the Address Field indicates the length of the Facility Field in octets. The facility length indicator is binary-coded, where bit 1 is the low-order bit of the indicator.

12.2.4.2.4 Facility field

The Facility Field contains an integral number of octets. The actual maximum length of this field depends on the facilities that are supported at the DTE/DXE interface. However, this maximum cannot exceed 109 octets.

See also:

- Coding of the Facility Field (clause 15).

12.3 DATA and INTERRUPT packets

The packets described in this sub-clause are used for transmitting data or are used with the interrupt procedure. They include the following packets:

- DATA (12.3.1);
- INTERRUPT (12.3.2); and
- INTERRUPT CONFIRMATION (12.3.3).

12.3.1 The DATA packet

Figure 16 illustrates the format of the DATA packet transmitted by a DTE as well as the format of the DATA packet received by a DTE.

The first three octets consist of the General Format Identifier, the Logical Channel Identifier, and the Packet Type Identifier Fields, as described in 12.1.1 through 12.1.3. In addition, bits 8 and 7 of octet 1 (part of the General Format Identifier) are used as noted below. When packet sequence numbering is performed modulo 8, bits 8 through 2 of octet 3 (part of the Packet Type Identifier) are used as noted below.

12.3.1.1 QUALIFIER bit

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

12.3.1.2 DELIVERY CONFIRMATION bit

Bit 7 of octet 1 is the Delivery Confirmation bit (D-bit).

12.3.1.3 Packet Receive Sequence Number

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

12.3.1.4 More Data bit

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

12.3.1.5 Packet Send Sequence Number

Bits 4, 3, and 2 of octet 3, or bits 8 through 2 of octet 3 when extended, are used for indicating the packet send sequence number P(S). P(S) is binary-coded, where bit 2 is the low-order bit.

12.3.1.6 User Data field

Octets following octet 3, or octet 4 when extended, contain user data. This field shall contain an integral number of octets, as indicated in 3.7. The maximum length of this field is described in 6.2.

12.3.2 INTERRUPT packet

Figure 17 illustrates the format of the INTERRUPT packet transmitted by a DTE as well as the format of the INTERRUPT packet received by a DTE.

The first three octets consist of the General Format Identifier, the Logical Channel Identifier, and the Packet Type Identifier Fields, as described in 12.1.1 through 12.1.3.

Interrupt User Data:

Octet 4 and any following octets contain the interrupt user data. This field contains from 1 to 32 octets and shall contain an integral number of octets, as indicated in 3.7.

12.3.3 INTERRUPT CONFIRMATION packet

Figure 18 illustrates the format of the INTERRUPT CONFIRMATION packet transmitted by a DTE as well as the format of the INTERRUPT CONFIRMATION packet received by a DTE.

This packet contains three octets. These octets consist of the General Format Identifier, the Logical Channel Identifier, and the Packet Type Identifier Fields, as described in 12.1.1 through 12.1.3.

12.4 Flow Control packets

The packets described in this sub-clause are used to control the flow of DATA packets (the DATA and REJECT packets, described in 12.3.1 and 12.8, respectively, are also used to control the flow of DATA packets). They include the following packets:

- a) RECEIVE READY (12.4.1); and
- b) RECEIVE NOT READY (12.4.2).

12.4.1 RECEIVE READY packet

Figure 19 illustrates the format of the RECEIVE READY packet transmitted by a DTE as well as the

format of the RECEIVE READY packet received by a DTE.

This packet contains three or four octets, depending on whether extended sequence numbering is used. The first three octets consist of the General Format Identifier, the Logical Channel Identifier, and the Packet Type Identifier Fields, as described in 12.1.1 through 12.1.3. However, when packet sequence numbering is performed modulo 8, bits 8, 7, and 6 of octet 3 (part of the Packet Type Identifier) are used as noted below.

Packet Receive Sequence Number:

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

12.4.2 RECEIVE NOT READY packet

Figure 20 illustrates the format of the RECEIVE NOT READY packet transmitted by a DTE as well as the format of the RECEIVE NOT READY packet received by a DTE.

This packet contains three or four octets, depending on whether extended sequence numbering is used. The first three octets consist of the General Format Identifier, the Logical Channel Identifier, and the Packet Type Identifier Fields, as described in 12.1.1 through 12.1.3. However, when packet sequence numbering is performed modulo 8, bits 8, 7, and 6 of octet 3 (part of the Packet Type Identifier) are used as noted below.

Packet Receive Sequence Number:

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

12.5 Reset packets

The packets described in this sub-clause are used to (re)initialize the flow of both DATA and INTERRUPT packets. They include the following packets:

- a) RESET REQUEST and RESET INDICATION (12.5.1); and
- b) RESET CONFIRMATION (12.5.2).

12.5.1 RESET REQUEST and RESET INDICATION packets

Figure 21 illustrates the format of RESET REQUEST and RESET INDICATION packets.

In a DTE/DCE environment, the RESET REQUEST packet and RESET INDICATION packet are two different "physical" packets because of the intervening network. However, in a DTE/DTE environment, the RESET REQUEST packet sent by one DTE is the same as the RESET INDICATION packet received by the other DTE.

The first three octets consist of the General Format Identifier, the Logical Channel Identifier, and the Packet Type Identifier Fields, as described in 12.1.1 through 12.1.3.

12.5.1.1 Resetting Cause Field

Octet 4 is the Resetting Cause Field and contains the reason for the reset.

The Resetting Cause Field in a RESET REQUEST packet shall be set to "DTE Originated" by a DTE.

The coding of the Resetting Cause Field in a RESET INDICATION packet is given in table 6 (the definition of each resetting cause is given in CCITT Recommendation X.96). *In a DTE/DCE environment, a DTE, in order to allow for possible later extensions to table 6, shall be able to accept any value in the Resetting Cause Field in a RESET INDICATION packet. In a DTE/DTE environment, a DTE may either handle a resetting cause other than "DTE Originated" as it does in a DTE/DCE environment (i.e., process the packet normally) or treat it as an error. In the latter case, the Packet Level transmits a RESET REQUEST packet with a cause indicating "DTE Originated" and the diagnostic "Improper Cause Code From DTE."*

12.5.1.2 Diagnostic Code field

Octet 5 is the Diagnostic Code Field and contains additional information on the reason for the reset. The coding of the Diagnostic Code Field is dependent on the resetting cause as given in figure 14A.

In a RESET REQUEST packet, the Diagnostic Code Field is required, even if it indicates no additional information.

In a RESET INDICATION packet, if the Resetting Cause Field indicates "DTE Originated," the Diagnostic Code Field has been passed unchanged from the remote DTE as a result of its having initiated a resetting procedure or, in a DTE/DCE environment, a restarting procedure. In a RESET

INDICATION packet, if the Resetting Cause Field does not indicate "DTE Originated," the Diagnostic Code Field is network generated.

NOTE — The contents of the Diagnostic Code Field do not alter the meaning of the Resetting Cause Field. A DTE is not required to undertake any action on the contents of the Diagnostic Code Field. The Resetting Cause Field has to be accepted even if the Diagnostic Code Field contains an unspecified code combination.

12.5.2 RESET CONFIRMATION packet

Figure 22 illustrates the format of the RESET CONFIRMATION packet transmitted by a DTE as well as the format of the RESET CONFIRMATION packet received by a DTE.

This packet contains three octets. These octets consist of the General Format Identifier, the Logical Channel Identifier, and the Packet Type Identifier Fields, as described in 12.1.1 through 12.1.3.

12.6 Restart packets

The packets described in this sub-clause are used to (re)initialize the DTE/DXE Packet Level interface. They include the following packets:

- a) RESTART REQUEST and RESTART INDICATION (12.6.1); and
- b) RESTART CONFIRMATION (12.6.2).

12.6.1 RESTART REQUEST and RESTART INDICATION packets

Figure 23 illustrates the format of RESTART REQUEST and RESTART INDICATION packets.

In a DTE/DCE environment, the RESTART REQUEST packet and RESTART INDICATION packet apply only at a local DTE/DCE interface. However, in a DTE/DTE environment, the RESTART REQUEST packet sent by one DTE is the same as the RESTART INDICATION packet received by the other DTE.

The first three octets consist of the General Format Identifier, the Logical Channel Identifier, and the Packet Type Identifier Fields, as described in 12.1.1 through 12.1.3. However, the Logical Channel Identifier Field is coded as all zeros.

12.6.1.1 Restarting Cause field

Octet 4 is the Restarting Cause Field and contains the reason for the restart.

The Restarting Cause Field in a RESTART REQUEST packet shall be set to "DTE Originated" by a DTE.

Table 6 — Coding of the resetting cause filed in reset indication packets

	OCTET 4 BITS: 8 7 6 5 4 3 2 1	NOTES
DTE Originated	0 0 0 0 0 0 0 0	1
DTE Originated	1 0 0 0 0 0 0 0	2
Out Of Order	X 0 0 0 0 0 0 1	3,4,5
Remote Procedure Error	X 0 0 0 0 0 1 1	3,4
Local Procedure Error	X 0 0 0 0 1 0 1	3,4
Network Congestion	X 0 0 0 0 1 1 1	3,4
Remote DTE Operational	X 0 0 0 1 0 0 1	3,4,5
Network Operational	X 0 0 0 1 1 1 1	3,4,5
Incompatible Destination	X 0 0 1 0 0 0 1	3,4
Network Out Of Order	X 0 0 1 1 1 0 1	3,4,5
Gateway-detected Procedure Error	1 1 0 0 0 0 0 1	3
Gateway Congestion	1 1 0 0 0 0 1 1	3
Gateway Operational	1 1 0 0 0 1 1 1	3,5

NOTES

- 1 Used when the Diagnostic Code Field is coded in accordance with figure 14B.
- 2 Used when the Diagnostic Code Field is not coded in accordance with figure 14B.
- 3 These resetting causes apply only to a DTE/DCE environment.
- 4 The bit indicated as "X" set to 0 indicates a resetting cause generated by a public data network and set to 1 indicates a resetting cause generated by a private network.
- 5 Applicable to Permanent Virtual Circuits only.

The coding of the Restarting Cause Field in a RESTART INDICATION packet is given in table 7 (the definition of each restarting cause is given in CCITT Recommendation X.96). In a DTE/DCE environment, a DTE, in order to allow for possible later extensions to table 7, shall be able to accept any value in the Restarting Cause Field in a RESTART INDICATION packet. In a DTE/DTE environment, a DTE may either handle a restarting cause other than "DTE Originated" as it does in a DTE/DCE environment (i.e., process the packet normally) or treat it as an error. In the latter case, the Packet Level transmits a RESTART REQUEST packet with a cause indicating "DTE Originated" and the diagnostic "Improper Cause Code From DTE."

12.6.1.2 Diagnostic Code field

Octet 5 is the Diagnostic Code Field and contains additional information on the reason for the restart. The coding of the Diagnostic Code Field is dependent on the restarting cause as given in figure 14A.

In a RESTART REQUEST packet, the Diagnostic Code Field is required, even if it indicates no additional information.

In network applications, the Diagnostic Code in a RESTART REQUEST packet is passed to the corresponding DTEs as the Diagnostic Code of a RESET INDICATION packet for Permanent Virtual Circuits or as the Diagnostic Code of a CLEAR INDICATION packet for Virtual Calls.

Table 7 — Coding of the restarting cause field in restart indication packets

	OCTET 4 BITS: 8 7 6 5 4 3 2 1	NOTES
DTE Originated	0 0 0 0 0 0 0 0	1,2
DTE Originated	1 0 0 0 0 0 0 0	1,3
Local Procedure Error	0 0 0 0 0 0 0 1	4
Network Congestion	0 0 0 0 0 0 1 1	4
Network Operational	0 0 0 0 0 1 1 1	4
Registration/Cancellation Confirmed	0 1 1 1 1 1 1 1	4,5

NOTES

- 1 These restarting causes apply only to a DTE/DTE environment.
- 2 Used when the Diagnostic Code Field is coded in accordance with figure 14B.
- 3 Used when the Diagnostic Code Field is not coded in accordance with figure 14B.
- 4 These restarting causes apply only to a DTE/DCE environment.
- 5 May be received only if the On-line Facility Registration Facility (see 13.1) is used.

NOTE — The contents of the Diagnostic Code Field do not alter the meaning of the Restarting Cause Field. A DTE is not required to undertake any action on the contents of the Diagnostic Code Field. The Restarting Cause Field has to be accepted even if the Diagnostic Code Field contains an unspecified code combination.

12.6.2 RESTART CONFIRMATION packet

Figure 24 illustrates the format of the RESTART CONFIRMATION packet transmitted by a DTE as well as the format of the RESTART CONFIRMATION packet received by a DTE.

This packet contains three octets. These octets consist of the General Format Identifier, the Logical Channel Identifier, and the Packet Type Identifier Fields, as described in 12.1.1 through 12.1.3. However, the Logical Channel Identifier Field is coded as all zeros.

12.7 The DIAGNOSTIC packet

Figure 25 illustrates the format of the DIAGNOSTIC packet.

All DTEs should be capable of receiving a DIAGNOSTIC packet. *The DIAGNOSTIC packet may be used in a DTE/DCE environment, and then only to be sent by a DCE to a DTE. The DIAGNOSTIC*

packet may be originated by a DTE only in a DTE/DTE environment provided its generation can be suppressed when connected to a network.

The first three octets consist of the General Format Identifier, the Logical Channel Identifier, and the Packet Type Identifier Fields, as described in 12.1.1 through 12.1.3. However, the Logical Channel Identifier Field is coded as all zeros.

12.7.1 Diagnostic Code field

Octet 4 is the Diagnostic Code Field and contains information on the error condition which resulted in the transmission of the DIAGNOSTIC packet. The coding of the Diagnostic Code Field is given in figure 14A.

12.7.2 Diagnostic Explanation field

When the DIAGNOSTIC packet is issued as a result of the reception of an erroneous packet (i.e., a packet with one of the conditions listed in figure 5B or 5C), this field contains the first three octets of header information from the erroneous packet. If the erroneous packet contains less than three octets, then this field contains *only integral octets, if any, that were received by a DTE in a DTE/DTE*