Superseded by a more recent version

INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

X.36

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

(04/95)

DATA NETWORKS AND OPEN SYSTEM COMMUNICATIONS

PUBLIC DATA NETWORKS – INTERFACES

INTERFACE BETWEEN DATA TERMINAL EQUIPMENT (DTE) AND DATA CIRCUIT-TERMINATING EQUIPMENT (DCE) FOR PUBLIC DATA NETWORKS PROVIDING FRAME RELAY DATA TRANSMISSION SERVICE BY DEDICATED CIRCUIT

ITU-T Recommendation X.36
Superseded by a more recent version

(Previously “CCITT Recommendation”)

FOREWORD

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

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

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

ITU-T Recommendation X.36 was prepared by ITU-T Study Group 7 (1993-1996) and was approved under the WTSC Resolution No. 1 procedure on the 10th of April 1995.

NOTE

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

Superseded by a more recent version

ITU-T X-SERIES RECOMMENDATIONS

DATA NETWORKS AND OPEN SYSTEM COMMUNICATIONS

(February 1994)

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SUMMARY

This Recommendation defines the DTE/DCE interface for public data networks providing frame relay data transmission service by dedicated circuit.

INTERFACE BETWEEN DATA TERMINAL EQUIPMENT (DTE) AND DATA CIRCUIT-TERMINATING EQUIPMENT (DCE) FOR PUBLIC DATA NETWORKS PROVIDING FRAME RELAY DATA TRANSMISSION SERVICE BY DEDICATED CIRCUIT

(Geneva, 1995)

1 Scope

This Recommendation defines interfaces between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) for public data networks providing frame relay data transmission service by dedicated circuit. It describes also the Frame Relay Data Transmission Service. It includes two cases:

1) the frame relay connection is permanently established;

2) the frame relay connection is established by messages of call signalling (not in this version).

NOTE – The Frame Relay Bearer Service for the ISDN environment has been defined in Recommendations Q.922, I.233.1 and I.370. Deliberate differences in this Recommendation catering for the different environment to the definitions for the ISDN environment are clearly marked in Appendix III.

2 References

The following ITU-T Recommendations, and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision: all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of currently valid ITU-T Recommendations is regularly published.

- CCITT Recommendation G.703, *Physical/electrical characteristics of hierarchical digital interfaces.*
- CCITT Recommendation G.704, *Synchronous frame structures used at primary and secondary hierarchical levels.*
- CCITT Recommendation G.732, *Characteristics of primary PCM multiplex equipment operating at 2048 kbit/s.*
- CCITT Recommendation I.122, *Framework for providing additional packet mode bearer services.*
- CCITT Recommendation I.233, *Frame mode bearer services.*
- CCITT Recommendation I.233.1, *ISDN frame relaying bearer service.*
- CCITT Recommendation I.370, *Congestion management for the ISDN frame relaying bearer service.*
- ITU-T Recommendation I.372, *Frame relaying bearer service network-to-network interface for the ISDN frame relaying bearer service.*
- ITU-T Recommendation I.430, *Basic user-network interface – Layer 1 specification.*
- ITU-T Recommendation I.431, *Primary rate user-network interface – Layer 1 specification.*
- CCITT Recommendation Q.922, *ISDN data link layer specification for frame mode bearer services.*
- ITU-T Recommendation Q.931, *Digital subscriber Signalling System No. 1 (DSS1) – ISDN user-network interface layer 3 specification for basic call control.*
- ITU-T Recommendation Q.933, *Digital subscriber Signalling System No. 1 (DSS1) – Signalling specification or frame mode basic call control.*

- ISO/IEC TR 8885, *Information technology – Telecommunications and information exchange between systems – High Level Data Link Control (HDLC) procedures – General purpose XID frame information field content and format.*
- ISO/IEC TR 9577, *Information technology – Telecommunications and information exchange between systems – Protocol identification in the network layer.*
- CCITT Recommendation X.21, *Interface between data terminal equipment and data circuit-terminating equipment for synchronous operation on public data networks.*
- CCITT Recommendation X.21 *bis*, *Use on public data networks of Data Terminal Equipment (DTE) which is designed for interfacing to synchronous V-Series modems.*
- ITU-T Recommendation X.25, *Interface between Data Terminal Equipment (DTE) and Data Circuit Terminating Equipment (DCE) for terminals operating in the packet mode and connect to a public data network by dedicated circuit.*
- ITU-T Recommendation X.144, *User information transfer performance parameters for data networks providing international frame relay PVC service.*
- CCITT Recommendation X.150, *Principles of maintenance testing for public data networks using data terminal equipment (DTE) and data circuit-terminating equipment (DCE) test loops.*

3 Terms and definitions

For the purpose of this Recommendation, the following definitions apply.

This Recommendation makes use of the following terms:

a) AR: see 8.2.1.

b) Bc: see 8.2.2.

c) Be: see 8.2.3.

d) CIR: see 8.2.4.

e) Tc: see 8.2.5.

f) N391: see 11.4 and Table 5-1.

g) N392: see 11.4 and Table 5-1.

h) N393: see 11.4 and Table 5-1.

i) T391: see 11.4 and Table 5-2.

j) T392: see 11.4 and Table 5-2.

NOTE – The name of these timers and counters of item from f) to j) are aligned with Annex A/Q.933 terminology.

4 Abbreviations

For the purpose of this Recommendation the following abbreviations are used:

AR Access Rate

Bc Committed Burst Size

Be Excess Burst Size

BECN Backward Explicit Congestion Notification

C/R Command/Response

CIR Committed Information Rate

CLLM Consolidated Link Layer Management

CLNP Connectionless Network Layer Protocol

D/C DLCI Extension/Control Indication Bit

DCE	Data Circuit-terminating Equipment
DE	Discard Eligibility indicator
DLCI	Data Link Connection Identifier
DTE	Data Terminal Equipment
EA	Address Field Extension
FCS	Frame Check Sequence
FDDI	Fibre Distributed Data Interface
FECN	Forward Explicit Congestion Notification
FRDTS	Frame Relay Data Transmission Service
IP	Internet Protocol
MAC	Media Access Control
OUI	Organizationally Unique Identifier
PDN	Public Data Network
PDU	Protocol Data Unit
PID	Protocol Identifier
PVC	Permanent Virtual Circuit
SNAP	Subnetwork Access Protocol
SVC	Switched Virtual Circuit
Tc	Committed Rate Measurement Interval

5 Conventions

No special conventions are employed within this Recommendation.

6 Description of the DTE/DCE interface (physical layer)

Administrations may offer one or more of the interfaces specified below. The exact use of the relevant points in these Recommendations is detailed below.

6.1 Recommendation X.21 interface

6.1.1 DTE/DCE interface element

The DTE/DCE physical interface element shall be according to 2.1 through 2.5/X.21.

6.1.2 Procedures for entering operational phases

The procedures for entering operational phases shall be as described in 5.2/X.21. The data exchanged on circuits T and R when the interface is in states 13S, 13R and 13 of Figure A.3/X.21 will be as described in subsequent clauses of this Recommendation. The not ready states given in 2.5/X.21 are considered to be non-operational states and may be considered by the higher layers to be out of order states.

6.1.3 Failure detection and test loops

The failure detection principles shall be according to 2.6/X.21. In addition, i = OFF may be signalled due to momentary transmission failures. Higher layers may delay for several seconds before considering the interface to be out of order.

The definitions of test loops and the principles of maintenance testing using the test loops are provided in Recommendation X.150.

A description of the test loops and the procedures for their use is given in clause 7/X.21.

Automatic activation by a DTE of a test loop 2 in the DCE at the remote terminal is not possible. However, some Administrations may permit the DTE to control the equivalent of a test loop 2, at the local DCE, to verify the operation of the leased line or subscriber line and/or all or part of the DCE or line terminating equipment. Control of the loop, if provided, may be either manual or automatic, as described in Recommendations X.150 and X.21 respectively.

6.1.4 Signal element timing

Signaling element timing shall be in accordance with 2.6.3/X.21.

6.2 X.21 *bis* interface

6.2.1 DTE/DCE physical interface elements

The DTE/DCE physical interface element shall be according to 1.2/X.21 *bis*.

6.2.2 Operational phases

When circuit 107 is in the ON condition, and circuits 105, 106, 108 and 109, if provided, are in the ON condition, data exchange on circuits 103 and 104 will be as described in subsequent clauses of this Recommendation.

When circuit 107 is in the OFF condition, or any of circuits 105, 106, 108 or 109, if provided, are in the OFF condition, this is considered to be in a non-operational state, and may be considered by the higher layers to be in an out of order state.

6.2.3 Failure detection and test loops

The failure detection principles, the description of test loops and the procedures for their use shall be according to 3.1 through 3.3/X.21 *bis*. In addition, circuits 106 and 109 may enter the OFF condition due to momentary transmission failures. Higher layers may delay for several seconds before considering the interface to be out of order.

Automatic activation by a DTE of test loop 2 in the DCE at the remote terminal is not possible. However, some Administrations may permit the DTE to control the equivalent of a test loop 2, at the local DCE, to verify the operation of the leased line or subscriber line and/or all or part of the line terminating equipment. Control of the loop, if provided, may be either manual or automatic, as described in Recommendations X.150 and X.21 *bis* respectively.

6.2.4 Signal element timing

Signal element timing shall be in accordance with 3.4/X.21 *bis*.

6.3 V-Series interfaces

General operation with V-Series modems is as described in 6.2 above. However, for specific details, particularly related to failure detection principles, loop testing, and the use of circuits 107, 109, 113 and 114, refer to the appropriate V-Series Recommendations.

The delay between 105 – ON and 106 – ON (when these circuits are present) will be more than 10 ms and less than 1 s. In addition, circuits 106 or 109 may enter the OFF condition due to momentary transmission failures or modern retraining. Higher layers may delay for several seconds before considering the interface to be out of order.

6.4 G-Series interfaces

The characteristics of the physical circuit interface, defined as the physical layer element, shall be in accordance with Recommendation G.703.

When used, the frame structure conforms to Recommendation G.704. In case of 2 Mbit/s, time slot 0 is used to perform the fault detection (see Recommendation G.732). Time slot 16 may either be used or not used, resulting in an access rate of 1984 kbit/s or 1920 kbit/s respectively.

6.5 I-Series interfaces

I-Series physical interfaces on PDN for Frame Relay Data Network Service are defined in Recommendations I.430 and I.431.

NOTE – I-Series physical interface is to be used for dedicated line in the PDN providing for FRDTS. In some cases semi-permanent channel interfaces from ISDN network will be used without channel negotiation procedure.

7 Description of services

7.1 General definition

FRDTS provides bidirectional transfer of frames from one DTE/DCE interface to another DTE/DCE interface with content transparency, error detection and order preservation of the transmitted frames.

FRDTS does not provide procedures for error notification, error recovery, re-transmission in case of lost frames.

Loss of frames can result not only from transmission errors but also from congestion within the network or at the DTE/DCE interfaces.

7.2 Multiplexing

FRDTS allows simultaneous connections between DTEs to be multiplexed on a single access circuit. Individual frames of a given connection are identified by means of an attached label. This field in the frame called DLCI (Data Link Connection Identifier is a logical identifier, with local significance. The network keeps a relationship between the DLCI used on one DTE/DCE interface and the DLCI used on the remote DTE/DCE interface for a given DTE to DTE connection (see Figure 1). Note that the mapping of DLCI value of transmitting DTE to receiving DTE is network dependent.

For each connection, the order of frames is preserved from the transmitting DTE to the receiving DTE.

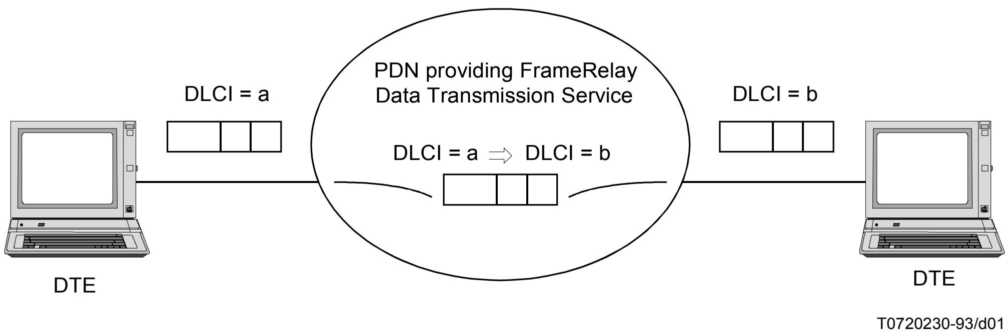


FIGURE 1/X.36

Data Link Connection Identifier

7.3 Service aspect

FRDTS provides both Switched Virtual Circuit (SVC) and Permanent Virtual Circuit (PVC) services (PVC only in this version).

8 Service parameters and Service quality

8.1 Scope

This clause describes the service parameters needed to ensure the necessary service requirements including congestion management.

8.2 Service parameters

8.2.1 Access Rate (AR)

The access rate is the maximum data rate that the DTE can inject into or extracted from the network. It is determined by the speed of the access channel which is selected by the user from a set supported by the network. It is agreed for a period of time.

8.2.2 Committed Burst Size (Bc)

The committed burst size is the amount of data for a particular virtual circuit that the network agrees to transfer under normal conditions during interval Tc [see 8.2.5 (Tc)].

The value of this service parameter for a given direction of transmission (i.e. outgoing direction from the DTE to the DCE and incoming direction from the DCE to the DTE) is set to a value selected from a set supported by the network and agreed to for a period of time. The value of this service parameter for a given direction of transmission can also be negotiated at call set-up.

8.2.3 Excess Burst Size (Be)

The excess burst size is the amount of uncommitted data that the network shall endeavor to accept in addition to the committed burst size (Bc) from a DTE for a particular virtual circuit during interval Tc [see 8.2.5 (Tc)].

The value of this service parameter for a given direction of transmission (i.e. outgoing direction from the DTE to the DCE and incoming direction from the DCE to the DTE) is set to a value selected from a set supported by the network and agreed for period of time. The value of this service parameter for a given direction of transmission can also be negotiated at call set-up.

8.2.4 Committed Information Rate (CIR)

The information transfer rate for a particular PVC which the network is committed to transfer under normal conditions. The rate is averaged over a minimum time interval of Tc.

The value of this service parameter for a given direction of transmission (i.e. outgoing direction from the DTE to the DCE and incoming direction from the DCE to the DTE) is set to a value selected from a set supported by the network and agreed for period of time. The value of this service parameter for a given direction of transmission can also be negotiated at call set-up.

8.2.5 Committed Rate Measurement Interval (Tc)

The committed rate measurement interval Tc is the time interval during which the network may expect committed burst size and excess burst size data. For each direction of transmission, it is defined according to the following formula:

1) If CIR > 0 Tc = Bc/CIR.
2) If CIR = 0, Tc is set to a value selected by the user from a set supported by the network. This value is agreed for a period of time.

8.2.6 Maximum octet length of Frame Relay Information Field (N203)

The size of the Frame Relay Information Field (N203 parameter) is the number of user data octets after the address field and before the Frame Check Sequence (FCS) field (see Figure 2). The count is done prior to zero-bit insertion on the transmitting side and following zero-bit extraction at the receiving side. The value of the N203 parameter for a given direction of transmission (i.e. outgoing direction from the DTE to the DCE and incoming direction from the DCE to the DTE) is set to a value selected from a set supported by the network and agreed to for a period of time. The value of the N203 parameter for a given direction of transmission can also be negotiated at call set-up.

All networks shall support at least the value of 1600 octets.

8.3 Service quality

The QOS level for committed traffic characterized by the CIR, Bc and Tc parameters may be delivered within a certain probability. The QOS for level excess traffic characterized by the parameter Be may also be delivered within a certain probability.

More detail on this aspects can be found in Recommendation X.144. Congestion occurrence within the network or at the DTE/DCE interfaces impacts the provided QOS level (see clause 12).

9 Data link transfer control

9.1 General

This clause contains the frame structure, elements of procedure, format of fields and procedures for the operation of the Frame Relay Data Transmission Service.

The functions provided by the Frame Relay Data Transmission Service are:

- frame delimiting, alignment and transparency;
- frame multiplexing/de-multiplexing using the address field;
- inspection of the frame to ensure that it consists of an integral number of octets prior to zero bit insertion or following zero bit extraction;
- inspection of the frame to ensure that it is neither too long nor too short;
- detection of (but not recovery from) transmission errors;
- congestion control functions.

9.2 Frame format

The frame format used for individual frame is shown in Figure 2.

8 7 6 5 4 3 2 1	
Flag	Octet 1
Address field first octet (Note)	Octet 2
Address field second octet	Octet 3
Information Field (N – 6) Octet	Octet 4 . . . Octet N – 3
Frame Check Sequence (first octet)	Octet N – 2
Frame Check Sequence (second octet)	Octet N – 1
Flag	Octet N

NOTE – The default address field length is 2 octets. It may be extended to either 3 or 4 octets.

FIGURE 2/X.36

Frame Format with 2 octet address

9.2.1 Flag sequence

All frames shall start and end with the flag sequence consisting of one 0 bit followed by six contiguous 1 bits and one 0 bit. The flag preceding the address field is defined as the opening flag. The flag following the Frame Check Sequence (FCS) field is defined as the closing flag. DTE and DCE must be able to support the use of the closing flag as the opening flag of the following frame.

9.2.2 Address field

The address field shall consist of at least two octets, and may optionally be extended up to 4 octets. The format of the address field is defined in 9.3.

9.2.3 Information field

The information field of a frame, when present, follows the address field (see 9.3.2) and precedes the frame check sequence field (see 9.2.5). The contents of the frame relay information field shall consist of an integral number of octets. The maximum length of the frame relay information field is defined in 8.2.6.

9.2.4 Frame Check Sequence (FCS) field

The FCS field shall be a 16-bit sequence. It shall be the ones complement of the sum (modulo 2) of:

1) the remainder of x^k $(x^{15} + x^{14} + x^{13} + x^{12} + x^{11} + x^{10} + x^9 + x^8 + x^7 + x^6 + x^5 + x^4 + x^3 + x^2 + x + 1)$ divided (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$, where k is the number of bits in the frame existing between, but not including, the final bit of the opening flag and the first bit of the FCS, excluding bits inserted for transparency; and

2) the remainder of the division (modulo 2) by the generator polynomial $x^{16} + x^{12} + x^5 + 1$ of the product of x^{16} by the content of the frame, existing between but not including, the final bit of the opening flag and the first bit of the FCS, excluding bits inserted for transparency.

9.3 Addressing

9.3.1 General

This subclause describes the format of the address field (see Figure 3). A frame relay connection is governed by the elements of the address field described in this subclause. These elements of the address field provide for the support of congestion management optional procedures which can be found in clause 12. The information field follows the address field.

9.3.2 Address field format

The address field shown in Figure 3 contains the address field extension bits, a command/response indication bit, a forward explicit congestion notification bit, a backward explicit congestion notification bit, a discard eligibility indication bit, Data Link Connection Identifier (DLCI) bits and a DLCI extension/Control indication bit (D/C bit). The support of 2 octets address field is mandatory. DTE and DCE may also support address fields with length of 3 octets and/or 4 octets. When the network supports address fields with length of 3 octets and/or 4 octets, the choice of the length is made at a subscription time and is applicable to the entire DTE/DCE interface.

9.3.3 The address field element

9.3.3.1 Address field extension bit (EA bit)

The address field range is extended by reserving bit 1 of the address field octets to indicate the final octet of the address field. The presence of a 0 in bit 1 of an address field octet signals that another octet of the address field follows this one. The presence of a 1 in bit 1 of an address field octet signals that it is the final octet of the address field.

9.3.3.2 Command/Response bit (C/R bit)

The C/R bit is conveyed transparently from one DTE to the other.

Default Address Field Format (2 octets)

8	7	6	5	4	3	2	1
Upper DLCI (6 bits)						C/R	EA 0
Lower DLCI (4 bits)				FECN	BECN	DE	EA 1

or

3 Octets Address Field Format

8	7	6	5	4	3	2	1
Upper DLCI (6 bits)						C/R	EA 0
DLCI (4 bits)				FECN	BECN	DE	EA 0
Lower DLCI (6 bits)						D/C 0	EA 1

or

4 Octets Address Field Format

8	7	6	5	4	3	2	1
Upper DLCI (6 bits)						C/R	EA 0
DLCI (4 bits)				FECN	BECN	DE	EA 0
DLCI (7 bits)							EA 0
Lower DLCI (6 bits)						D/C 0	EA 1

EA	Address Field Extension Bit
C/R	Command Response Bit
FECN	Forward Explicit Congestion Notification
BECN	Backward Explicit Congestion Notification
DLCI	Data Link Connection Identifier
DE	Discard Eligibility Indicator
D/C	DLCI Extension/Control Indication Bit

FIGURE 3/X.36

Address field format

9.3.3.3 Forward Explicit Congestion Notification Bit (FECN bit)

This bit may be set by a congested network to notify the receiving DTE that congestion avoidance procedures should be initiated, where applicable for traffic in the direction of the frame carrying the FECN indication. This bit is set to 1 to indicate to the receiving DTE that the frames it receives have encountered congested resources. This bit may be used by destination DTE to initiate transmitter rate adjustment.

While setting this bit by the network or DTE is optional, no network shall ever clear (set to 0) this bit. Networks that do not provide FECN shall pass this bit unchanged. Explanations on the use of this bit are contained in clause 12.

9.3.3.4 Backward Explicit Congestion Notification Bit (BECN bit)

This bit may be set by a congested network to notify the receiving DTE that congestion avoidance procedures should be initiated, where applicable for traffic in the opposite direction of the frame carrying the BECN indication. This bit is set to 1 to indicate to the receiving DTE that the frames it transmits may encounter congested resources. This bit may be used by the source DTE to initiate transmitter rate adjustment.

While setting this bit by the network or DTE is optional, no network shall ever clear (set to 0) this bit. Networks that do not provide BECN shall pass this bit unchanged. Explanations on the use of this bit are contained in clause 12.

9.3.3.5 Discard Eligibility Indicator Bit (DE bit)

This bit, if used, is set to 1 to indicate a request that a frame should be discarded in preference to other frames in a congestion situation. Setting of this bit by the network or DTE is optional. No network shall ever clear (set to 0) this bit. Networks are not constrained to discard only frames with DE = 1 in the presence of congestion.

9.3.3.6 Data Link Connection Identifier (DLCI)

Depending on the length of the address field, the DLCI can be 10 bits, 16 bits or 23 bits.When the length of the address field is 2 octets, the DLCI is 10 bits and appears in octets 1 and 2. When the length of the address field is 3 octets, the DLCI is 16 bits and appears in octets 1, 2 and 3. When the length of the address field is 4 octets, the DLCI is 23 bits and appears in octets 1, 2, 3 and 4. See Figure 3.

The DLCI identifies a virtual circuit at the local DTE/DCE interface. Its value is determined at subscription time for permanent virtual circuits and at call setup time for switched virtual circuits. The maximum number of virtual circuits supported for a DTE/DCE interface is network dependent.

Specific values of the DLCI are also used for:

- the signalling for switched virtual circuits (see clause 10);
- the additional procedures for permanent virtual circuits (see clause 11);
- layer 2 management, in particular the Consolidated Link Layer Management (CLLM) (see Annex C).

The various values for DLCI are specified in Tables 1-1, 1-2 and 1-3.

TABLE 1-1/X.36

DLCI value range when 2 octets address field is used

DLCI range (10 bits)	Function	Reference
0	Signalling	10, 11
1 - 15	Reserved	
16 - 991	Virtual circuit identification	
992 - 1007	Layer 2 management of FRDTS used for information related to the network such as the Consolidated Link Layer Management (CLLM) messages	Annex C
1008 - 1022	Reserved	
1023	Reserved for in channel layer 2 management, if required	

TABLE 1-2/X.36

DLCI value range when 3 octets address field is used

DLCI range (16 bits)	Function	Reference
0	Signalling	10, 11
1 - 1023	Reserved	
1024 - 63487	Virtual circuit identification	
63488 - 64511	Layer 2 management of FRDTS used for information related to the network such as the Consolidated Link Layer Management (CLLM) messages	Annex C
64512 - 65534	Reserved	
65535	Reserved for in channel layer 2 management, if required	

TABLE 1-3/X.36

DLCI value range when 4 octets address field is used

DLCI range (23 bits)	Function	Reference
0	Signalling	10, 11
1 - 131071	Reserved	
131072 - 8126463	Virtual circuit identification	
8126464 - 8257535	Layer 2 management of FRDTS used for information related to the network such as the Consolidated Link Layer Management (CLLM) messages	Annex C
8257536 - 8388606	Reserved	
8388607	Reserved for in channel layer 2 management, if required	

9.3.3.7 DLCI extension Control indication bit (D/C bit)

The D/C bit is bit 2 of the last octet of the address field when a 3 octets or 4 octets format is used. It is always set to 0 in this Recommendation. When set to 1, the bits 3 to 8 of this last octet are no longer interpreted as DLCI bits and their use is for further study.

9.4 Transmission consideration

9.4.1 Order of bit transmission

The bits are grouped into octets. The bits of an octet are shown horizontally and are numbered from 1 to 8. Multiple octets are shown vertically and are numbered from 1 to n (See Figure 4).

The octets are transmitted in ascending numerical order. For each octet: bit 1, which is the least significant bit, is transmitted first and bit 8, which is the most significant bit, is transmitted last.

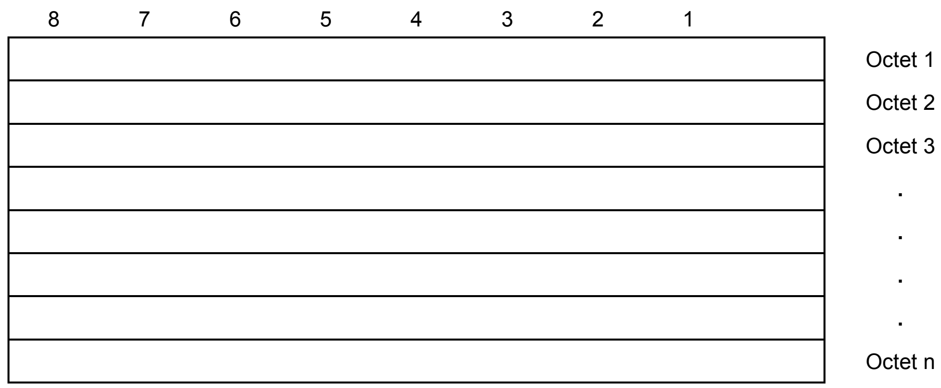


FIGURE 4/X.36

Format convention

9.4.2 Order of bits in frame fields

When a field is contained within a single octet, the lowest bit number of the field represents the lowest order value.

When a field spans more than one octet, the order of bit values progressively decreases as the octet number increases within each octet. The lowest bit number associated with the field represents the lowest order value.

For example in an address field with length of two octets, the order of the values of the DLCI bits is as shown in Figure 5.

8	7	6	5	4	3	2	1	
Upper DLCI (6 bits) 2^9	2^8	2^7	2^6	2^5	2^4	C/R	EA 0	Octet 1
Lower DLCI (4 bits) 2^3	2^2	2^1	2^0	FECN	BECN	DE	EA 1	Octet 2

FIGURE 5/X.36

Order of values of the DLCI bits

There are two exceptions to the preceding convention:

1) The order of the values of the bits within the information field is not specified in this Recommendation.

2) The order of the values of FCS bits is as follows: bit 1 of the first octet is the high-order bit and bit 8 of the second octet is the low-order bit (See Figure 6).

8	7	6	5	4	3	2	1	
2^8	2^9	2^{10}	2^{11}	2^{12}	2^{13}	2^{14}	2^{15}	Octet 1
2^0	2^1	2^2	2^3	2^4	2^5	2^6	2^7	Octet 2

FIGURE 6/X.36

Order of values of the FCS bits

9.4.3 Transparency

The DTE and DCE shall examine the frame contents between the opening and closing flag sequences (address, information, and FCS fields) and shall insert a "0" bit after all sequences of five contiguous "1" bits (including the last five bits of the FCS) to ensure that a flag or an abort sequence is not simulated within the frame. The receiving DTE and DCE shall examine the frame contents between the opening and closing flag sequences and shall discard any "0" bit which directly follows five contiguous "1" bits.

9.4.4 Inter frame fill

For inter frame fill flag sequence must also be used.

9.4.5 Invalid frame

An invalid frame is a frame which:

a) is not properly bounded by two flags; or

b) has fewer than two octets between the address field and the closing flag; or

c) does not consist of an integral number of octets prior to a "0" bit insertion or following "0" bit extraction; or

d) contains a frame check sequence error; or

e) contains a single octet address field; or

f) contains a DLCI which is not supported by the receiver; or

g) contains 7 or more continuous bits set to 1 after "0" bit insertion or before "0" bit extraction ("transparency violation" or "frame abort"); or

h) has an information field longer than N203 (see 8.2.6).

NOTES

1 Item b) above means that frames with an information field length equal to 0 are valid frames. In case there is no traffic on a given transmission direction, the DTE or the DCE may use such frames to send information about congestion in the opposite direction by means of the BECN bit set to 1 or to 0. For backward compatibility reasons, DTE or DCE may consider as invalid such frames, and consequently discards them without notification to the transmitting DCE or DTE.

2 In case h) above, the network may send part of the frame toward the remote DTE then abort the frame.

Invalid frames shall be discarded without notification to the transmitting DTE or DCE.

9.4.6 Frame abortion

Aborting a frame is performed by transmitting at least seven contiguous 1 bits (with no inserted 0 bits). The receipt of seven or more contiguous 1 bits by a DTE (or a DCE) is interpreted as an abort and the DTE (or the DCE) ignores the frame currently being received.

10 Call connection control

Call connection control is for further study.

11 PVC management procedures

11.1 Overview

These procedures described in 11.2-11.7 provide the following functionalities:

- link integrity verification of the DTE/DCE interface;
- notification to the DTE of the addition of a PVC;
- detection by the DTE of the deletion of a PVC;
- notification to the DTE of the status of a PVC.

These procedures are based on periodic transmission of a STATUS ENQUIRY message by the DTE and STATUS message by the DCE.

The support of these procedures are mandatory for the network. The DTE has to indicate at subscription time whether or not it will use these procedures. In addition, for example, when the DTE is a private network, bi-directional procedures as described in 11.5 may be used. It is optional for the network to support these procedures. The DTE has to indicate at subscription time whether or not it will use the bi-directional procedures.

11.2 Message definition

Both messages are transferred on DLCI = 0, FECN,BECN and DE bits are not used and must be set to 0 upon transmission and must not be interpreted upon reception. The 3 octets following the address field have fixed values:

- the first octet is the control field of a UI frame with P bit set to 0;
- the 2nd octet is the protocol discriminator information element of the message;
- the 3rd octet is the dummy call reference information element of the message.

Consequently, the first octets of the frame are as described in Figure 7.

The other information elements are described in 11.2.1 and 11.2.2 below.

Octet	8	7	6	5	4	3	2	1	
1	Flag								
2	0	0	0	0	0	0	0	0	Address field
3	0	0	0	0	0	0	0	1	DLCI = 0
4	0	0	0	0	0	0	1	1	UI P = 0
5	0	0	0	0	1	0	0	0	Protocol discriminator
6	0	0	0	0	0	0	0	0	Dummy call reference
	Message specific information element								See 11.2.1 and 11.2.2
	FCS								
	Flag								

FIGURE 7/X.36

PVC management frame format (for 2 octets address)

11.2.1 STATUS ENQUIRY message

This message is sent to request the status of PVCs or to verify link integrity. Message specific information elements for this messages are described in Table 2, and are in the order indicated in this Table.

TABLE 2/X.36

Message specific information elements in STATUS ENQUIRY message

Message type: STATUS ENQUIRY Significance: Local	Direction: Both		
Information element	Direction	Type	Length
Message type	Both	Mandatory	1
Report type	Both	Mandatory	3
Link integrity verification	Both	Mandatory	4

11.2.2 STATUS message

This message is sent in response to a STATUS ENQUIRY message to indicate the status of permanent virtual circuits or for a link integrity verification. Optionally, it may be sent at any time to indicate the status of a single PVC. Message specific information elements for this message are described in the Table 3, and are in the order indicated in the table. Moreover, the PVC status information element may occur several times.

TABLE 3/X.36

Message specific information elements in STATUS message

Message type: STATUS Significance: Local	Direction: Both		
Information element	Direction	Type	Length
Message type	Both	Mandatory	1
Report type	Both	Mandatory	3
Link integrity verification	Both	Optional/Mandatory (Note)	4
PVC status	Both	Optional/Mandatory (Note)	5-7
NOTE – Optional or Mandatory depending on the type of report. See 11.4.			

11.3 Message specific information elements

11.3.1 Message type

The coding of message type is defined in Table 4.

TABLE 4/X.36

Message type coding

Message type coding for PVC management Bits 8765 4321 011 - - - - - 1 0101 STATUS ENQUIRY 1 1101 STATUS

11.3.2 Report type

The purpose of the Report type information element is to indicate the type of enquiry requested when included in a STATUS ENQUIRY message or the contents of the STATUS message. The length of this information element is 3 octets. The format of the Report type information element is defined in Figure 8, where the type of report is indicated in octet 3.

8	7	6	5	4	3	2	1	Octet
0	1	0	1	0	0	0	1	1
Length of report type contents								2
Type of report								3

Type of report (octet 3)

Bits

87654321

00000000 Full status (status of all PVCs on the DTE/DCE interface)

00000001 Link integrity verification only

00000010 Single PVC asynchronous status

All other values are reserved

FIGURE 8/X.36

Report type information element

11.3.3 Link integrity verification

The purpose of the Link integrity verification information element is to exchange sequence numbers between the DCE and the DTE on a periodic basis. The length of this information element is 4 octets. The length of the contents of the link integrity information element is binary encoded in octet 2.

The format of the Link integrity verification information element is defined in the Figure 9, where send sequence number in octet 3 indicates the current send sequence number of the originator of the message, and receive sequence number in octet 4 indicates the send sequence number received in the last received message. The send sequence number is binary encoded in octet 3. The receive sequence number is encoded in octet 4.

8	7	6	5	4	3	2	1	Octet
0	1	0	1	0	0	1	1	1
Length of link integrity verification contents = 2								2
Send sequence number								3
Receive sequence number								4

FIGURE 9/X.36

Link integrity verification information element

11.3.4 PVC status

The purpose of the PVC status information element is to indicate the status of existing PVCs at the interface. The information element can be repeated, as necessary, in a message to indicate the status of all PVCs on the DTE/DCE interface. The length of this information element depends on the length of the DLCIs being used on the DTE/DCE interface. The length of this information element is 5 octets when a default address format (2 octets) is used. The format of the PVC status information element is defined in the Figure 10-1, where a default address format is used. Bit 6 of octet 3 is the most significant bit in the data link connection identifier.

The format of the PVC status information element is defined in the Figures 10-2 and 10-3, where a 3 octets address format and a 4 octets address format are used respectively.

Bit 2 of the last octet for each PVC status information element is Active bit, which is coded 1 to indicate the PVC is active, and coded 0 to indicate the PVC is inactive. An active indication means that the PVC is available to be used for data transfer. An inactive indication means that the PVC is configured but is not available for data transfer.

Bit 3 of the last octet for each PVC status information element is Delete bit, which is coded 1 to indicate the PVC is deleted, and coded 0 to indicate the PVC is configured.

Bit 4 of the last octet for each PVC status information element is New bit, which is coded 1 to indicate the PVC is newly configured, and coded 0 to indicate the PVC is already configured.

The PVC status information elements are arranged in the messages in ascending order of DLCIs; the PVC with the lowest DLCI is first, the second lowest DLCI is second, and so on. The maximum number of PVCs that can be indicated in a message is limited by the maximum frame size.

The Delete bit is only applicable for timely notification using the optional single PVC asynchronous status report. When this bit is set to 1, the New and Active bits have no significance and shall be set to 0 upon transmission and not interpreted upon reception. When the New or Active bits have significance, the Delete bit shall be set to 0 upon transmission and not interpreted upon reception.

11.4 Description of procedures

These procedures use periodic polling, as described in 11.4.1 to verify the integrity of the link (see 11.4.1.2) and to report the status of the PVCs (see 11.4.1.3, 11.4.1.4 and 11.4.1.5).

<table>
<tr><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>Octet</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td colspan="8">Length of PVC status contents = 3</td><td>2</td></tr>
<tr><td>0
ext.</td><td>0
spare</td><td colspan="6">Data Link connection identifier
(Most significant 6 bits)</td><td>3</td></tr>
<tr><td>1
ext.</td><td colspan="4">Data Link connection identifier
(2nd most significant 4 bits)</td><td colspan="3">0 0 0
spare</td><td>3a</td></tr>
<tr><td>1
ext.</td><td colspan="3">0 0 0
spare</td><td>New
“N”</td><td>Delete
“D”</td><td>Active
“A”</td><td>0
reserved</td><td>4</td></tr>
</table>

FIGURE 10-1/X.36

PVC STATUS information element with 2 octets address format

<table>
<tr><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>Octet</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td colspan="8">Length of PVC status contents = 4</td><td>2</td></tr>
<tr><td>0
ext.</td><td>0
spare</td><td colspan="6">Data Link connection identifier
(Most significant 6 bits)</td><td>3</td></tr>
<tr><td>0
ext.</td><td colspan="4">Data Link connection identifier
(2nd most significant 6 bits)</td><td colspan="3">0 0 0
spare</td><td>3a</td></tr>
<tr><td>1
ext.</td><td colspan="6">Data Link connection identifier
(3rd most significant 6 bits)</td><td>0
spare</td><td>3b</td></tr>
<tr><td>1
ext.</td><td colspan="3">0 0 0
spare</td><td>New
“N”</td><td>Delete
“D”</td><td>Active
“A”</td><td>0
reserved</td><td>4</td></tr>
</table>

FIGURE 10-2/X.36

PVC STATUS information element with 3 octets address format

11.4.1 Periodic Polling

11.4.1.1 General

The DTE initiates the polling described below.

1) The DTE sends a STATUS ENQUIRY message to the DCE and starts the polling timer T391. When T391 expires, the DTE repeats the above action.

   This STATUS ENQUIRY message typically requests a link integrity verification exchange only (report type equal '0000 0001'). However every N391 polling cycles, the DTE requests full status of all PVCs (report type equal '0000 0000').

2) The DCE responds to each STATUS ENQUIRY message with a STATUS message and starts or restarts the polling verification timer T392 used by the network to detect errors (see 11.4.1.5). The STATUS message sent in response to a STATUS ENQUIRY contains the link integrity verification and report type information elements. If the content of the report type information element specifies full status, then the STATUS message must contain one PVC status information element for each PVC configured on the DTE/DCE interface.

3) The DTE shall interpret the STATUS message depending upon the type of report contained in this STATUS message. The DCE may respond to any poll with a full status message in case of a PVC status change or to report the addition or deletion of PVC on the DTE/DCE interface. If it is a full status message, the DTE should update the status of each configured PVC.

8	7	6	5	4	3	2	1	Octet
0	1	0	1	0	1	1	1	1
Length of PVC status contents = 5								2
0 ext.	0 spare	Data Link connection identifier (Most significant 6 bits)						3
0 ext.	Data Link connection identifier (3rd most significant 4 bits)				0	0 spare	0	3a
0 ext.	Data Link connection identifier (3rd most significant 7 bits)							3b
1 ext.	Data Link connection identifier (4th most significant 6 bits)						0 spare	3c
1 ext.	0	0 spare	0	New "N"	Delete "D"	Active "A"	0 reserved	4

FIGURE 10-3/X.36

PVC STATUS information element with 4 octets address format

11.4.1.2 Link integrity verification

The purpose of the link integrity verification information element is to allow the DTE and the DCE to determine the status of the signaling link (DLCI 0). This is necessary since these procedures use the Unnumbered Information (UI) frame.

Figure 11 shows the normal Link integrity verification procedure.

The DTE and the DCE maintain the following internal counters:

– The send sequence counter maintains the value of the send sequence number field of the last link integrity verification information element sent.

– The receive sequence counter maintains the value of the last received send sequence number field in the link integrity verification information element and maintains the value to be placed in the next transmitted received sequence number field.

The following procedure is used:

1) Before any messages are exchanged, the DCE and the DTE set the send sequence counter and receive sequence counter to zero.

2) Each time the DTE sends a STATUS ENQUIRY message, it increments the send sequence counter and places its value into the send sequence number field. It also places the current value of the receive sequence counter into the receive sequence number field of the link integrity verification information element. The DTE increments the send sequence counter using modulo 256. The value zero is skipped.

3) When the DCE receives a STATUS ENQUIRY from the DTE, the DCE checks the receive sequence number received from the DTE against its send sequence counter. The handling of error conditions is described in 11.4.1.6.

The received send sequence number is stored in the receive sequence counter. The DCE then increments its send sequence counter and places its current value in the send sequence number field and the value of the receive sequence counter (the last received send sequence number) into the receive sequence number field of the outgoing link integrity verification information element. The DCE then transmits the completed STATUS message back to the DTE. The DCE increments the send sequence counter using modulo 256. The value zero is skipped.

4) When the DTE receives a STATUS from the DCE in response to a STATUS ENQUIRY, the DTE checks the receive sequence number received from the DCE against its send sequence counter. The handling of error conditions is described in 11.4.1.6. The received send sequence number is stored in the receive sequence counter.

NOTE – The value zero in the receive sequence number indicates that the field contents are undefined, this value is normally used after initialization. The value zero shall not be sent in the send sequence number field so that the receive sequence number shall never contain the value zero to differentiate the undefined condition from the normal modulo round off.

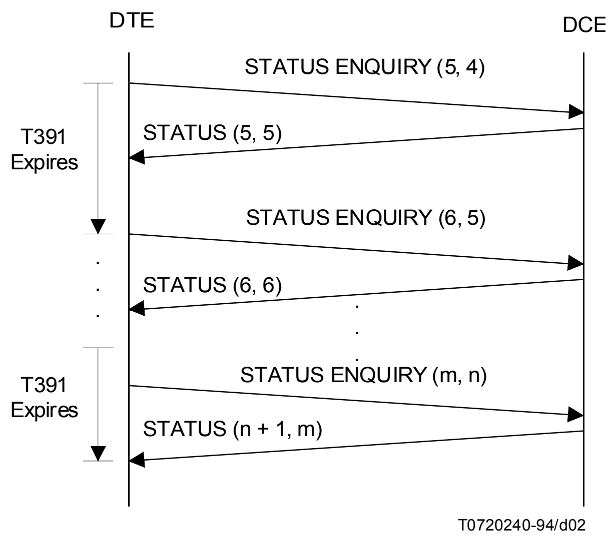


FIGURE 11/X.36

Link integrity verification

11.4.1.3 Signalling of the presence or absence of a PVC

The DCE will signal the presence of a PVC by including a PVC status, i.e. with the appropriate DLCI in a status message with full status report. A PVC should be considered as present when it is configured in the network in which the DCE is located.

The DTE shall interpret the omission of a previously reported PVC from the full status message as an indication that the PVC is no longer provisioned at the DTE/DCE interface.

11.4.1.4 Signalling that a PVC is new

One of the functions of periodic polling is to notify the DTE of newly added permanent virtual circuits using a full status message. The PVC reporting procedure using a full status message ensures that a permanent virtual circuit cannot be deleted and another added using the same DLCI without the DTE detecting the change. The PVC reporting procedures are defined as follows:

1) When a new permanent virtual circuit has been added, the DCE sets the New bit to 1 in the PVC status information element for that PVC in a full status STATUS message.

2) The DCE shall not clear the new bit in the PVC status information element until it receives a STATUS ENQUIRY message containing a receive sequence number equal to the send sequence counter (i.e. the send sequence number transmitted in the last STATUS message).

3) When the DTE receives a full status message containing a PVC status information element identifying an unknown DLCI and the New bit is set to 1, the DTE marks this PVC as new and adds it to its list of PVCs.

   NOTE – When the New bit is set to 1, the Delete bit must be set to 0 on transmission. On reception, the Delete bit is not interpreted when the New bit is set to 1.

11.4.1.5 Signalling the activity status of PVCs

In response to a STATUS ENQUIRY message sent by the DTE containing a report type information element set to "full status", the DCE reports in a STATUS message to the DTE the activity status of each PVC configured on the DTE/DCE interface with PVC status information elements (one per PVC).

The report type information element in this STATUS message is set to "full status". Also in response to a STATUS ENQUIRY message sent by the DTE containing a report type information element set to "link integrity verification only", the DCE may respond with a STATUS message containing a report type information element set to "full status" in case of a PVC status change. Each PVC status information element contains an Active bit indicating the activity status of that PVC.

The action that the DTE takes based on the value of the Active bit is independent of the action based on the New bit. The DTE could get a PVC status information element with the New bit set to 1 and the Active bit set to 0.

If the DTE receives a PVC status information element with the Active bit set to 0, the DTE shall stop transmitting frames on the PVC until it receives a PVC status information element for that PVC with the Active bit set to 1. When the Active bit is set to 1, the Delete bit must be set to 0 on transmission. The Delete bit is not interpreted in the full status reporting STATUS message. When the Delete bit set to 1 in the optional asynchronous status message, the active bit has no significance. Other action taken by the DTE is implementation dependent.

Since there is a delay between the time the network makes a PVC active and the time the DCE transmits a PVC status information element notifying the DTE, there is a possibility of the DTE receiving frames on a PVC marked as inactive. The action the DTE takes on receipt of frames on an inactive PVC is implementation dependent.

Since there is a delay between the time the network detects that a PVC has become inactive and the time the DCE transmits a PVC status information element notifying the DTE, there is a possibility of the DCE receiving frames on an inactive PVC. The action the DCE takes on receipt of frames for an inactive PVC is network dependent and may include the dropping of frames on the inactive PVC.

The DCE will signal that a PVC is active if the following criteria are met:

– The PVC is configured and available for data transfer in the network from the local DCE to the remote DCE.

– There is no service affecting condition at both local and remote DTE/DCE interfaces.

– In the case bidirectional procedures (see 11.5) are used at the remote DTE/DCE interface, the remote DTE indicates that the PVC is present and active.

Note that in the case bidirectional procedures are used at the local DTE/DCE interface, this indication is independent of the indication received from the local DTE.

11.4.1.6 Error monitoring

The DTE and DCE use the information provided by periodic polling for error monitoring.

The DTE and DCE detect the following error conditions:

– *Procedure errors* – Non-receipt of STATUS/STATUS ENQUIRY messages, or invalid receive sequence number in a link integrity verification information element.

– *Protocol errors* – Protocol discriminator, message type, call reference and mandatory information element errors.

In case of protocol errors, DTE and DCE shall ignore such messages: no response, no error count, no use of content of link integrity verification information.

Examples of procedure errors are given in Appendix I.

11.4.1.6.1 DCE actions

Several kinds of errors have to be taken into account by the DCE:

1) *Errors within the network*

The DCE shall set the Active bit to 0 for a PVC if a service affecting condition occurs within the network (implementation dependent, e.g. switching node or internal link out of order, etc.).

2) *Errors at the DTE/DCE interface*

For the purpose to determine a service affecting condition at the DTE/DCE interface, an event is defined as:

– receipt of a STATUS ENQUIRY message with no protocol errors; or

– expiration of timer T392.

The first type of event is considered as an error if the contents of the link integrity verification information element is invalid. This consists of an invalid receive sequence number. The receive sequence number is not valid when it is not equal to the last transmitted send sequence number.

Note – The DCE continues periodic polling procedure regardless the value of the received receive sequence number (i.e. the DCE answers to every STATUS ENQUIRY message with no protocol errors).

The second type of event is always considered as an error.

Detecting N392 of the last N393 events are in error indicates a service affecting condition. At the detection of a service affecting condition at the DTE/DCE interface by the DCE, the network should notify the remote DTE for each PVC whose service is affected restored by setting the Active bit to 0 in a full status STATUS message or optionally in a single PVC asynchronous PVC STATUS message.

The DCE shall continue link integrity verification procedures to detect service restoration. Detecting N392 consecutive events have occurred without error indicates service restoration.

3) *Loss of STATUS message with full status*

The DCE detects that its previous STATUS message with full status report has not been correctly received by the DTE when it receives from the DTE a STATUS ENQUIRY message that contains a receive sequence number that does not match the DCE send sequence counter (see 11.4.1.2). In this case, the DCE may indicate in the STATUS that it transmits:

– the report type with full status;

– PVC status.

The above is performed even if the received STATUS ENQUIRY does not contain a request for full status STATUS message.

4) *Recovery condition*

When the network detects that the service affecting condition is cleared, the DCE resumes normal operation of active PVC. The network shall notify the DTE for each PVC whose service is restored by the setting active bit to 1 in a full status message which is sent as a response to a STATUS ENQUIRY message or optionally in a single PVC asynchronous PVC STATUS message.

11.4.1.6.2 DTE actions

Several kinds of errors have to be taken into account by the DTE:

1) *Errors at the DTE/DCE interface*

For the purpose to determine a service affecting condition at the DTE/DCE interface, an event is defined as the transmission of a STATUS ENQUIRY messages.

This event is considered as an error in the following cases:

– non-receipt of a STATUS message with no protocol errors and with report type equal to "full status" or "link integrity verification only" before T391 expires;

– receipt of a STATUS message with report type equal to "full status" or "link integrity verification only" that contains invalid contents of an information element. This consists of detecting an invalid receive sequence number. The received receive sequence number is not valid when it is not equal to the last transmitted send sequence number.

NOTE –When the DTE received a STATUS message with no protocol errors but with an invalid receive sequence number, the DTE ignores such message including its send sequence number. Using the send sequence number of such STATUS message may cause the DTE to acknowledge a STATUS message with report type equal to "full status" that has been ignored (i.e. acknowledgement of the New bit and/or deletion status).

Detecting N392 errors in the last N393 events indicates a service affecting condition. The DTE may also use additional methods for detecting service affecting conditions.

At the detection of a service affecting condition at the DTE/DCE interface, the DTE should stop transmission of frames on all PVCs on the DTE/DCE interface. The DTE should continue link integrity verification procedures to detect service restoration.

When the DTE detects that the service affecting conditions is cleared, it resumes normal operation of active PVCs on the DTE/DCE interface. Detecting N392 consecutive events have occurred without error indicates service restoration.

This procedure detects problems with the signalling link (DLCI = 0) and does not detect problems with individual PVCs.

2) *Discrepancies about PVC status*

If the DTE receives a PVC status information element for a PVC not currently defined and the New bit is set to 0, the DTE records this as an error and adds the PVC to the active PVCs. Other actions taken by the DTE are implementation dependent.

If the DTE receives a full status STATUS message with no PVC status information element for a PVC that the DTE is currently using, the DTE shall remove that PVC from its list of PVCs.

3) *Loss of STATUS message with full status*

When the DTE has transmitted a STATUS ENQUIRY messages with requesting a full status report and has not received the corresponding STATUS message (i.e. with a full status report) before timer T391 expires, it may repeat this request for full status report in the STATUS ENQUIRY message it sends.

11.4.2 Asynchronous PVC STATUS message

It is optional for the network to support this message. In addition, when supported by the network, the DTE chooses at subscription time whether or not the DCE may transmit this message to it. The asynchronous PVC STATUS message is a STATUS message with only a report type information element set to "single PVC asynchronous status" and one PVC status information element. The asynchronous status message is set by a DCE to inform the DTE of an activity status change for given PVC. This message is transmitted asynchronously, i.e. independently of STATUS ENQUIRY message sent by the DTE. When a PVC is deleted, the DCE may send an asynchronous PVC STATUS message to the DTE that contains the report type information element set to "single PVC asynchronous status" and the PVC status information element. In the PVC status information element, the Delete bit is set to 1. When the Delete bit is set to 1, the New bit and the Active bit have no significance. They must be set to 0 on transmission and should not be interpreted on reception.

The procedures for reporting new PVCs are not supported by the asynchronous status messages. In an asynchronous PVC STATUS message, the New bit has no significance. It must be set to 0 on transmission and should not be interpreted on reception.

11.5 Optional bidirectional network procedures

It is optional for the network and the DTE to support these procedures. When supported by the network, the DTE chooses at subscription time whether or not the DCE uses these procedures. These procedures are mainly intended for the case where the DTE is a private network.

Figure 12 shows bidirectional procedure principle.

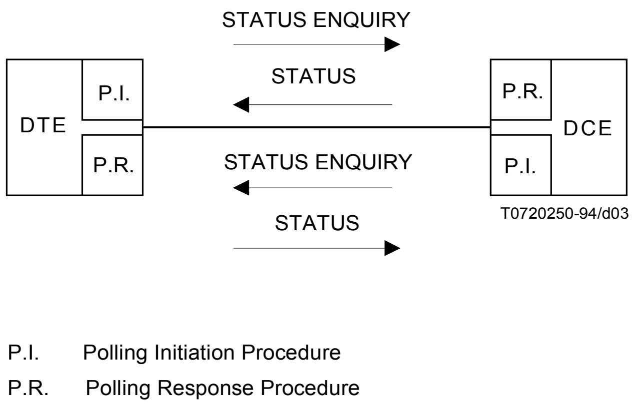


FIGURE 12/X.36

Bidirectional procedure principles

The DTE sends STATUS ENQUIRY message and the DCE responds with STATUS message. The procedures in 11.4.1 apply.

The DCE sends STATUS ENQUIRY message and the DTE responds with STATUS message. The procedures in 11.4.1 apply with the roles of DTE and DCE reversed. The following considerations apply.

Periodic polling

Both the DTE and DCE drives periodic polling procedures as described in 11.4.1.1, i.e. both the DTE and DCE implement T391, T392 and N391.

Link integrity verification

Two sets of sequence numbers are used by the DCE and DTE for Link Integrity Verification procedures. The first set is used when the DTE sends STATUS ENQUIRY message and the DCE responds with STATUS message. The second set is used when the DCE sends STATUS ENQUIRY message and the DTE responds with STATUS message.

Error monitoring

The DTE and the DCE must both implement two sets of parameters N392 and N393. One set is used by the polling initiation procedure (see 11.4.1.6.1), and one set is used by the polling response procedure (see 11.4.1.6.2). It is recognized that in the DTE or DCE, the polling initiation procedure and the polling response procedure may detect different states. Determination of the state of the DTE/DCE interface from these states is implementation dependent.

Signalling that a PVC is new

For a given PVC when the New bit received by the DCE is set to 1, this means that the PVC has been newly added or reconfigured on the DTE side (e.g. in a private network). This information shall be propagated across the network to the remote DTE/DCE interface.

NOTE – This procedure assures that the remote DTE does not miss the fact that the DTE (e.g. private network) deleted a PVC and then quickly re-used the same DLCI for a new PVC to a new destination.

11.6 System parameters

Tables 5-1 and 5-2 summarize the acceptable values for the configurable parameters described in these procedures. Parameter values other the default values are a subscription option.

TABLE 5-1/X.36

System parameters counters

Counter	Description	Range	Default/ threshold	Usage	Entity transmitting STATUS ENQUIRY (Note 1)	Entity answering with STATUS (Note 2)
N391	Full status (status of all PVCs) polling counter	1-255	6	Polling cycles	Mandatory	Not applicable
N392	Error/recovery counter	1-10 (Note 3)	3	Errored events/ No errored events	Mandatory	Mandatory
N393	Monitored events counter	1-10 (Note 4)	4	Events	Mandatory	Mandatory

NOTES

1 Supported by the DTE for PVC management procedures. Supported by the DCE for bidirectional procedures.

2 Supported by the DCE for PVC management procedures. Supported by the DTE for bidirectional procedures.

3 N392 should be less than or equal to N393.

4 If N393 is set to a value much less than N391, then the link could go in and out-of error condition without the DTE or network being notified.

TABLE 5-2/X.36

System parameters timers

Timer	Description	Range	Default (seconds)	Started	Actions taken when expired	Entity transmitting STATUS ENQUIRY (Note 1)	Entity answering with STATUS (Note 2)
T391	Link integrity verification polling timer	5-30	10	Transmit STATUS ENQUIRY	Transmit STATUS ENQUIRY Record error if STATUS message not received	Mandatory	Not applicable
T392	Polling verification timer	5-30 (Note 3)	15	Transmit STATUS	Record error by incrementing N392 Restart T392	Not applicable	Mandatory

NOTES

1 Supported by the DTE for PVC management procedures. Supported by the DCE for bidirectional procedures.

2 Supported by the DCE for PVC management procedures. Supported by the DTE for bidirectional procedures.

3 T392 should be less than or equal to T391.

12 Congestion control

12.1 General

Under normal operation DCE should be able to receive data transmitted from individual DTEs and transfer that data with a minimum delay at the user data transfer rate (i.e. the access rate of the physical subscriber lines) to a remote DTE. However, when DCE suffering from a mild congestion, there is delay when frames received from individual DTEs cannot be transmitted immediately and are instead stored in buffers for a short time before transmission to the remote DTE, thus resulting in an increased the frame transfer delay.

If the network congestion worsens to the point where the network can no longer transmit user frames at the rate with which they are being transmitted by DTE, the frames thus stored in buffers will cause the buffers to overflow, causing the overflow frames to be discarded.

Users can avoid this congestion from occurring and prevent their data frames from being discarded by reducing their transmitting data rate into the network to the CIR at subscription time. It is for this reason that it is necessary to consider factors such as total CIR rate for all PVC services accommodated on the network, the percentage of usage allocated to data transmission and reception for each link, and the ratio of this usage percentage to the rate of the physical lines when setting the capacity specifications for PVC services.

To guarantee the quality of FRDTS network services it is first necessary to ensure that the percentage of frames discarded during normal operation stays below a certain level. And while it is not possible to guarantee the same level of reliability at times of congestion, it is necessary to ensure that the percentage of frames discarded stays below the level needed to accommodate minimum levels of communications. In case of severer congestion, data transmission service must be stopped in order to recover network resources, and it will be impossible to ensure the data transmission.

Figure 13 shows the relation between the level of congestion on the network and the throughput for user-transmitted data. Here it can be seen that at times of congestion the discarding of frames and retransmission of user frames leads to decreased overall throughput.

Region I of Figure 13 indicates the throughput of the network during normal condition, Region II indicates its condition at times of mild congestion, and Region III its condition at times of severe congestion.

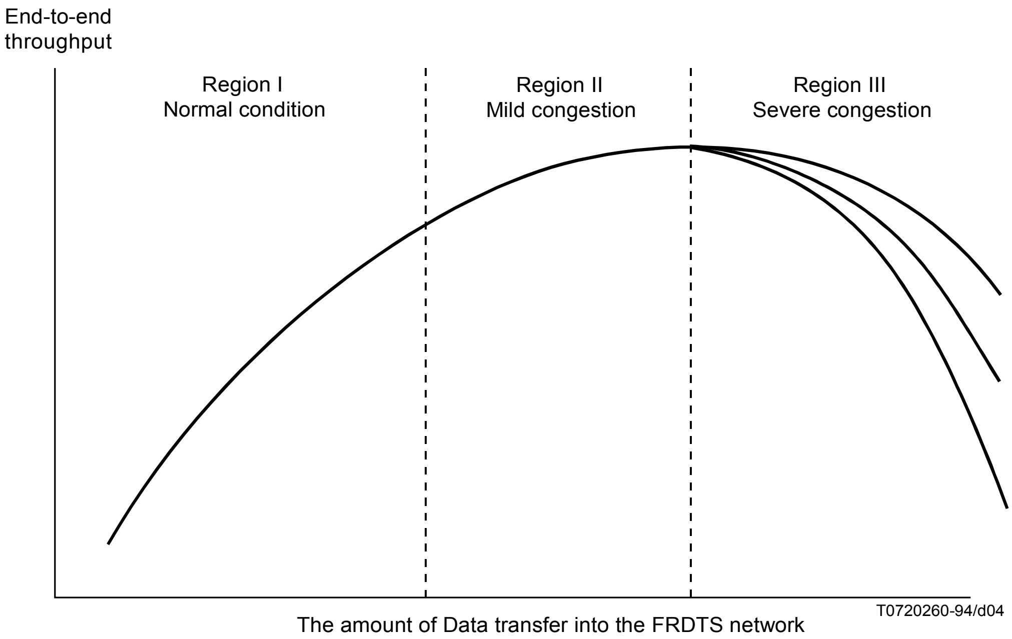


FIGURE 13/X.36

Relation between network congestion and throughput

12.2 Impact of congestion

At the onset of mild congestion, the network must implement procedures to detect congestion, notify the DTEs, and where possible control excess traffic so as to avoid as far as possible the actual discarding of frames. The network should send messages explicitly notifying DTEs that congestion exists within the network. DTEs should respond to such messages by reducing traffic transmitted to the network, thus allowing the network to recover from congestion.

In times of congestion, networks will generally discard those frames marked as Discard Eligible (DE) in preference to other traffic. However, networks may discard any frames at any time to protect themselves from congestion collapse. The only method of controlling the traffic from DTEs which do not respond to congestion notification is to discard frames.

12.3 Congestion notification

When the network detects a state of congestion, it may set to 1 the FECN and/or BECN bits in frames transmitted to the concerned DTEs (see Figure 14). Some networks may also send a CLLM message to the concerned DTEs (see Annex C).

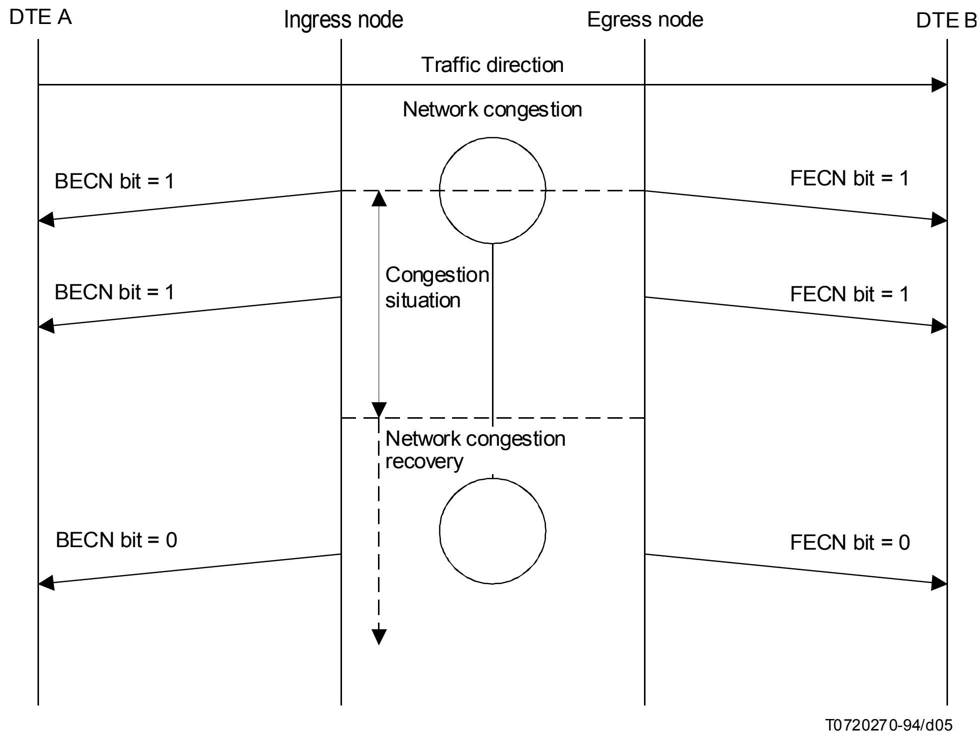


FIGURE 14/X.36

Network congestion notification

12.3.1 Forward explicit congestion notification

Notification in the same direction as the traffic causing the network to congestion is called forward explicit congestion notification. The network sets the FECN bit "1" within the address field of the frame passing the congested node to inform the receiving user of the network congestion (see Figure 15).

Note that FECN bit may be set by the DTE to notify the network and/or the remote DTE.

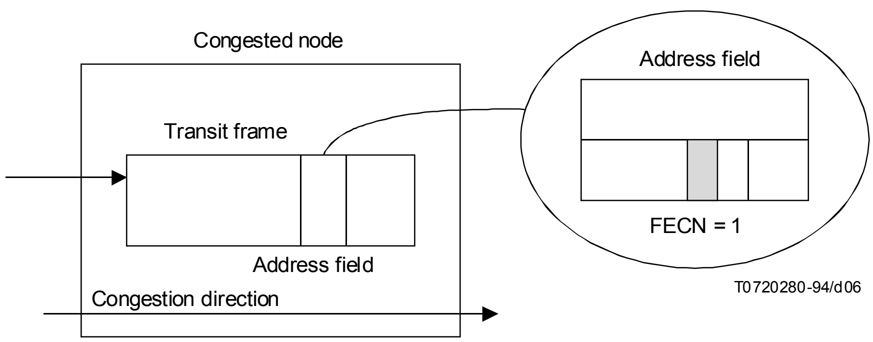


FIGURE 15/X.36

Congestion notification using FECN bit

12.3.2 Backward explicit congestion notification

Notification in the reverse direction of the traffic causing network congestion is called backward explicit congestion notification. The network sets the BECN bit "1" within the address field of the frame passing the congested node to inform the receiving DTE of network congestion (see Figure 16).

Note that the BECN bit may be set by the DTE to notify the network and/or the remote DTE.

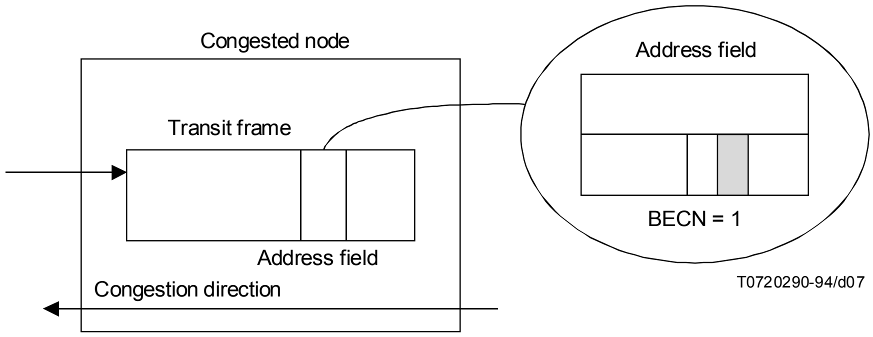


FIGURE 16/X.36

Congestion notification using BECN bit

12.4 DTE congestion detection method and actions

Appendix II gives guidance on the methods that the DTE may use to detect and react to the network congestion.

Annex A

List and status of the X.36 parameters

(This annex forms an integral part of this Recommendation)

Table A.1 gives the list of parameters for a frame relay DTE/DCE interface. The column "DTE" indicates whether this parameter has to be supported by the DTE for proper operations. The column "DCE" indicates whether the parameters must be supported by all networks complying with this Recommendation. When both the DTE and the DCE use the parameter for a given PVC or DTE/DCE interface, the next column indicates whether the DTE value should be the same as the DCE value. The last column indicates whether the parameter is defined per DTE/DCE interface or per PVC.

When a parameter is supported by the network, the user may select the value at subscription time among these supported by the network.

TABLE A.1/X.36

List of parameters for a DTE/DCE interface

Counter/ Timer/ Parameter	Reference	DTE	DCE	Same value required for DTE and DCE	Significance
AR	8.2.1	Mandatory	Mandatory	Yes	Per interface
DLCI	9.3.3.6	Mandatory	Mandatory	Yes	Per PVC
CIR	8.2.4	Optional	Mandatory	Yes	Per PVC
Bc	8.2.2	Optional	Mandatory	Yes	Per PVC
Be	8.2.3	Optional	Mandatory	Yes	Per PVC
Tc (when CIR = 0)	8.2.5	Optional	Mandatory	Yes	Per PVC
N203	8.2.6	Mandatory	Mandatory	Yes	Per PVC
Support of PVC management	11	Optional	Mandatory	Yes	Per interface
N391	11.6	Mandatory	Not applicable	Not applicable	Per interface
N392	11.6	Mandatory	Mandatory	Advisable	Per interface
N393	11.6	Mandatory	Mandatory	Advisable	Per interface
T391	11.6	Mandatory	Not applicable	Not applicable	Per interface
T392	11.6	Not applicable	Mandatory	Not applicable	Per interface
Support of PVC bidirectional procedure	11.5	Optional	Optional	Yes	Per interface
T391	11.6	Mandatory	Not applicable	Not applicable	Per interface
T392	11.6	Not applicable	Mandatory	Not applicable	Per interface
Support of PVC bidirectional procedure	11.5	Optional	Optional	Yes	Per interface
N391 (second set)	11.5	Not applicable	Mandatory	Not applicable	Per interface
N392 (second set)	11.5	Mandatory	Mandatory	Advisable	Per interface
N393 (second set)	11.5	Mandatory	Mandatory	Advisable	Per interface
T391 (second set)	11.5	Not applicable	Mandatory	Not applicable	Per interface
T392 (second set)	11.5	Mandatory	Not applicable	Not applicable	Per interface
Support of asynchronous PVC status message	11.4.2	Optional	Optional	Advisable	Per interface
Support of CLLM message	Annex C	Optional	Optional	Yes	Per interface
Tx	C.5.4	Not applicable	Mandatory	Not applicable	Per interface
Ty	C.5.4	Mandatory	Not applicable	Not applicable	Per interface

Annex B

Functional support at the DTE/DCE interface

(This annex forms an integral part of this Recommendation)

B.1 Protocol Capabilities (PC)

The Protocol Capabilities support mandatory/optional are defined in Table B.1.

TABLE B.1/X.36

Protocol Capability (PC)

Index	Protocol Features	Reference	Support Status	
			DTE	DTE
Transmission features				
PC1	STATUS ENQUIRY transmit	11.2	Optional	Optional
PC2	STATUS answer	11.2	Optional	Mandatory
PC3	Asynchronous STATUS message transmit	11.6	Optional	Optional
PC4	2 octet address field support and transmit	9.3.2	Mandatory	Mandatory
PC5	3 octet address field support and transmit	9.3.2	Optional	Optional
PC6	4 octet address field support and transmit	9.3.2	Optional	Optional
PC7	Ability to set FECN bit to 1	9.3.3.3	Optional	Optional
PC8	Ability to set BECN bit to 1	9.3.3.4	Optional	Optional
PC9	Ability to set DE bit to 1	9.3.3.5	Optional	Optional
PC10	CLLM message transmit	Annex C	Optional	Optional
Reception features				
PC11	STATUS ENQUIRY receive	11.2	Optional	Mandatory
PC12	STATUS receive	11.2	Optional	Optional
PC13	Asynchronous STATUS message receive	11.6	Optional	Optional
PC14	2 octet address field support and receive	9.3.2	Mandatory	Mandatory
PC15	3 octet address field support and receive	9.3.2	Optional	Optional
PC16	4 octet address field support and receive	9.3.2	Optional	Optional
PC17	Transparency to FECN bit set to 1	9.3.3.3	Not Applicable	Mandatory
PC18	Transparency to BECN bit set to 1	9.3.3.4	Not Applicable	Mandatory
PC19	Transparency to DE bit set to 1	9.3.3.5	Not Applicable	Mandatory
PC20	CLLM message receive	Annex C	Optional	Optional

B.2 Frames protocol data units (FR)

The Protocol data units support mandatory/optional are defined in Table B.2.

TABLE B.2/X.36

Protocol data units (FR)

Index	Protocol Features	Reference	Support Status	
			DTE	DTE
Common features				
FR1	All frames start and end with a flag	9.2.1	Mandatory	Mandatory
FR2	Address field default of two octets	9.3.2	Mandatory	Mandatory
FR3	Address field extended to three octets	9.3.2	Optional	Optional
FR4	Address field extended to four octets	9.3.2	Optional	Optional
FR5	Field mapping convention (lowest bit number represents the lowest order value)	9.2.1	Mandatory	Mandatory
Transmitting features				
FR6	Generate a single flag (the closing flag is also the open flag)	9.2.1	Optional	Optional
FR7	Transparency (insertion of a “0” bit after five “1” bits)	9.4.2	Mandatory	Mandatory
FR8	Order of bit transmisssion	9.4.1	Mandatory	Mandatory
FR9	FCS field of transmit	9.2.4	Mandatory	Mandatory
FR10	Interframe fill with flag sequence	9.4.3	Mandatory	Mandatory
Reception features				
FR11	Accept the closing flag as the open flag of the next frame	9.2.1	Mandatory	Mandatory
FR12	Transparency (discard an “0” bit after five “1” bits)	9.4.1	Mandatory	Mandatory
FR13	Order of bit of receiving	9.4.1	Mandatory	Mandatory
FR14	FCS field receiving	9.2.4	Mandatory	Mandatory
FR15	Ability to receive continuous flags as interframe fill	9.4.3	Mandatory	Mandatory
FR16	Discard invalid frames	9.4.4	Mandatory	Mandatory

B.3 System Parameters (SP)

System Parameters support mandatory/optional are defined in Table A.1.

Annex C

Consolidated Link Layer Management (CLLM) message

(This annex forms an integral part of this Recommendation)

The consolidated link layer management message is based on ISO 8885 definition of XID frames for transport function information. The use of the CLLM messages is optional for both the DTE and the DCE. The frame format for the CLLM message is as shown in Figure C.1.

Each parameter is described using the sequence type-length-value. The following subclauses describe the functional fields for the consolidated link layer management message. The CLLM message may be transmitted whenever congestion control procedure is being performed as a result of network congestion, line or equipment failure or the performance of maintenance functions. All fields are binary encoded unless otherwise specified.

	87654321	
1	11111010	Address Octet 1
2	11110001	Address Octet 2
3	10101111	XID Control Field
4	10000010	Format Identifier (130)
5	00001111	Group Identifier = 15
6		Group Length Octet 1
7		Group Length Octet 2
8	00000000	Parameter identifier = 0
9	00000100	Parameter Length (4)
10	01101001	Parameter value = 105 (IA5 coded 1)
11	00110001	Parameter value = 49 (IA5 coded 1)
12	00110010	Parameter value = 50 (IA5 coded 2)
13	00110010	Parameter value = 50 (IA5 coded 2)
14	00000010	Parameter identifier = 2 (cause id)
15	00000001	Parameter length = 1
16		Cause value
17	00000011	Parameter Identifier = 3 (DLCI identifier)
18		Parameter Length
19	.	DLCI value Octet 1 (1st)
20	.	DLCI value Octet 2 (1st)
.		
.		
2n + 17		DLCI value Octet 1 (nth)
2n + 18		DLCI value Octet 2 (nth)
2n + 19		FCS octet 1
2n + 20		FCS octet 2

FIGURE C.1/X.36

2 octets address field CLLM message format

C.1 Address octets

This Recommendation provides only for address fields with a length of 2 octets. Further study is required on whether or not support is to be provided later for address fields with a length of 3 or 4 octets.

Since the length of the address field is set at 2 octets, the 6 high-order bits from the 8th to the 3rd bit within the first octet are reserved for the first 6 bits of the DLCI, while the 4 high-order bits of the second octet from the 8th to the 5th bit are reserved for the 4 low-order bits of the DLCI. Note that CLLM messages are classified as maintenance frames within the network, and they must be coded with a decimal value of DLCI = 1007 or to its binary equivalent of DLCI = 1111101111.

The second bit within the first octet is the Command/Response (C/R) bit, used to indicate whether the frame is a command or a response. As the CLLM message is an XID response frame, this must be coded with a value of R = 1. FECN, BECN and DE bits are not used, must be set to 0 upon transmission and must not be interpreted upon reception.

C.2 Control field

Octet 3 contains the control field code point for this type of message. This presents the control field for XID with a binary value of '1010111'.

C.3 XID information field

C.3.1 Format identifier field

Octet 4 contains the format identifier field. The format identifier field is defined by ISO 8885 to have a length of 1 octet. The general purpose format identifier is assigned the decimal value 130.

C.3.2 Group field

C.3.2.1 Group identifier field

Octet 5 contains the group identifier field. The group identifier field is decimal 15, which is assigned by ISO 8885 to indicate private parameters.

C.3.2.2 Group length field

Octet 6 and 7 contain the group length field. This 16-bit field describes the "length" of the octets in the remainder of the group field. The maximum value of the group length field is 256.

C.3.2.3 Group value field

The group value field consists of two or more parameter fields. The parameter set identification (with a parameter value 0) identifies the set of private parameters within the group field per ISO 8885/DAD3 as an identifier to determine. The other parameters ~~are~~ shall appear in the following order: cause identifier and then DLCI identifier.

C.3.3 Parameter set identification parameter

The parameter set identification parameter shall always be present; otherwise the CLLM message is ignored.

C.3.3.1 Parameter set identification field

Octet 8 contains the parameter identification field for the first parameter, and is set to 0 per ISO 8885/DAD3 Parameter 0 identifies the set of ~~a~~ private parameters within this group.

C.3.3.2 Parameter set identification length field

Octet 9 contains the length of the parameter 0 and is set to a binary value of '100' (i.e. a decimal value of 4).

C.3.3.3 Parameter value field

Octets 10 to 13 identify that this usage of the XID frame private parameter group is for I.122 private parameters.

Octet 10 contains the IA5 value of 'I' (decimal 105).

Octet 11 contains the IA5 value of '1' (decimal 49).

Octets 12 and 13 each contains the IA5 value for '2' (decimal 50).

C.3.4 Cause identifier parameter field

The cause identifier is required, and the frame is ignored if the cause identifier parameter field is not included within the CLLM message.

C.3.4.1 Parameter identifier field

Octet 14 contains the cause identifier field. The parameter identifier field is set to 2.

C.3.4.2 Parameter length field

Octet 15 contains the length of the cause identifier. This shall be set to binary "1".

C.3.4.3 Cause value

Octet 16 contains the cause value. This octet identifies the cause of this message as determined by the congested network node whose layer management module originated the message. The value for the cause set here is set to indicate the network status of the layer management entity issuing this message (e.g. congestion, failure, or maintenance operation). The values which may be coded in this field are shown in Table C.1.

The CLLM message shall not be ignored because of an unknown cause value.

NOTE – Cause values shall be coded as "short term" if the CLLM is sent due to a transient condition (e.g. one anticipated to have a duration on the order of seconds or minutes); otherwise, they shall be coded as "long term". Usage shall be network specific.

TABLE C.1/X.36

Codes for Cause of CLLM message

Bits	Cause
87654321	
00000010	Network congestion due to excessive traffic – short term
00000011	Network congestion due to excessive traffic – long term
00000110	Facility or equipment failure – short term
00000111	Facility or equipment failure – long term
00001010	Maintenance action – short term
00001011	Maintenance action – long term
00010000	Unknown – short term
00010001	Unknown – long term
	All other values are reserved.

C.3.5 DLCI identifier parameter field

DLCI identifier parameter fields are used to determine the DLCI corresponding to the cause listed in the CLLM messages listed above. If the DLCI identifier is missing, then the frame shall be ignored.

C.3.5.1 Parameter identifier field

Octet 17 contains the parameter identifier field. When the parameter identifier field is set to 3, the following octets of this parameter contain the DLCI(s) of the frame relay connection(s) that are congested.

C.3.5.2 Parameter length field

Octet 18 contains the length of DLCI(s) being reported, in octets. For example, if(n) DLCIs are being reported and they are of length two octets each, this will be 2 times(n) in octet size.

C.3.5.3 Parameter value field

Octet 19 through to the FCS octets contain the DLCI value(s) which identify logical link(s) that have encountered a congested state. The DLCI field is 10 bits long and contained in bits 8 to 3 of the first octet pair and bits 8 to 5 of the next octet of the pair. The bit 8 of the first octet is the most significant bit and bit 5 of the second octet is the least significant. The bits 2 to 1 in the first octet and bits 4 to 1 in the second octet are reserved.

87654321		
xxxxxx**	Octet 1	The high-order 6 bits of the DLCI are stored in the bits marked 'xxxxxx'.
xxxx****	Octet 2	The low-order 4 bits of the DLCI are stored in the bits marked 'xxxx'.
		The bits marked with asterisks (*) are reserved for later use.

C.4 FCS field

The last two octets of the frame contain the frame check sequence field.

C.5 Network CLLM message transmission procedure

The network transmits a CLLM message whenever it is unable to successfully transmit traffic from the DTE as a result of equipment failure or the congestion of resources due to excessive levels of traffic, thus informing the DTE of the network status. The purpose of sending a CLLM message is to request the DTE to reduce the overall amount of traffic.

C.5.1 Network congestion

When the network encounters resource congestion as a result of excessive levels of the DTE traffic and the level of traffic continues at these high levels, the network may be forced to discard traffic or bring the system to a halt for recovery. By sending a CLLM message to the DTE indicating the cause underlying the congestion, the network informs the DTE of the possibility of such action being taken. Note that since CLLM messages generated at times of congestion are intended only for providing notification in the opposite direction to that of the traffic causing the congestion, they are sent only in the opposite direction to the traffic congestion direction (see Figure C.2). CLLM messages may signal a congestion to the transmitting DTE when there is no traffic in the reverse direction.

C.5.1.1 Mild network congestion

When the status of network buffers and resources cause the network to fall into a state of mild congestion (as defined in 12.1), the network sends a message to the DTE informing it of the congestion and requiring it to restrict the traffic submitted to the network so that the network can recover before it becomes necessary to discard excess traffic.

C.5.1.2 Severe network congestion

When the status of network buffers and resources cause the network to fall into a state of severe congestion (as defined in 12.1), the network becomes unable to function without discarding traffic and accordingly sends a CLLM message to the DTE informing the DTE of the congestion and its cause while simultaneously discarding the excess traffic. Doing this enables the network to recover its resources and prepare for recovery to normal working status. Having received notice from the network of the discarding of traffic, the DTE should restrain from generating further traffic or halt operation to allow the network to recover. The CLLM message is sent by the network to inform the DTE that a possibility exists of its traffic being discarded.

C.5.2 Network failure

When an equipment failure or line fault occurs in the network, a code indicating the cause underlying the failure or error is stored in a CLLM message and transmitted to the DTE. When the DTE receives this failure message, it will recognize that a failure has occurred within the network and is required to halt the transmission of all traffic over the FR connection in question.

C.5.3 Notification of network maintenance action

When the network undergoes a continued period of severe congestion to the point where it adversely affects the operation of the network equipment or where the common network resources are overloaded by traffic from a specific DTE, and the network thus becomes unable to continue providing normal communications quality as specified by contract for low-traffic DTEs (e.g. DTEs communicating over links at volumes within the specified value for the CIR), the network may halt for short periods of time transmissions over high-traffic links, with those links with the highest level of traffic being given top priority for the halting of operation. The network will then transmit a CLLM message indicating the cause for the link stoppage to the link for which communications have been halted to inform the DTE of the action taken.

C.5.4 Recovery from cause given in the CLLM message

NOTE – These recovery procedures do not exist in the present text of Recommendation Q.922 (1992).

When the DCE has transmitted a CLLM message for a given set of DLCIs, it must transmit a CLLM message each Tx period, as long as the cause is valid for at least one DLCI. When the DTE receives a CLLM message with the same cause as the previous one, but with modifications in the list of DLCIs, it should consider that the CLLM message cause is no longer valid for the connections corresponding to the missing DLCIs. Every time the DTE receives a CLLM message, it should start or restart a Ty timer. When this timer expires the DTE should consider that the CLLM message cause is no longer valid for all the DLCIs (see Table C.2, Figure C.2 and Figure C.3).

TABLE C.2/X.36

CLLM timers

Timer	Description	Range	Default (seconds)	Started when	Actions taken when expired
Tx (DCE)	CLLM message send interval timer	5-30	10	Transmit CLLM message	Repeat CLLM if the causes still valid
Ty (DTE) (Note)	CLLM message recovery timer	5-30	11	Receive CLLM message	Consider the cause no longer valid
NOTE – Ty should be greater than Tx.					

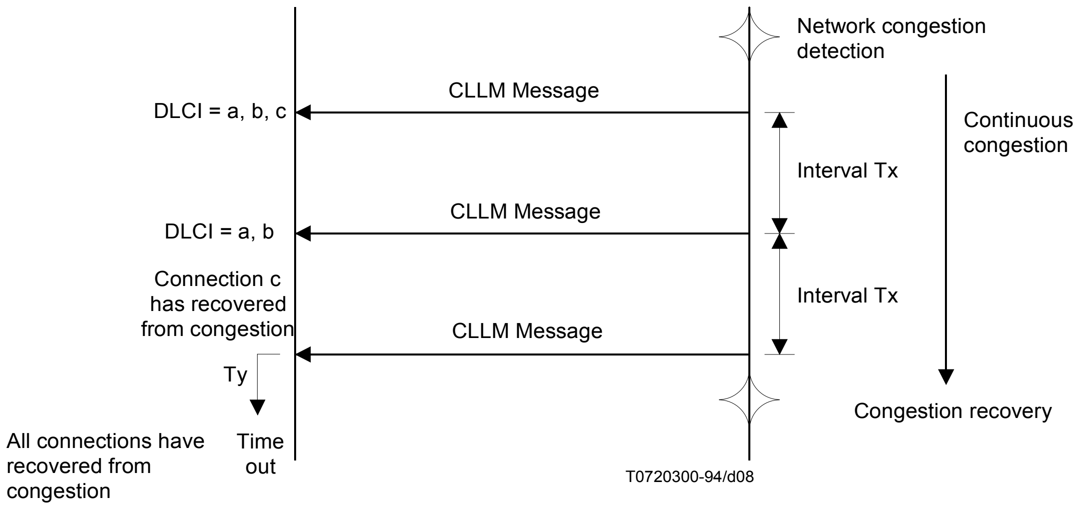
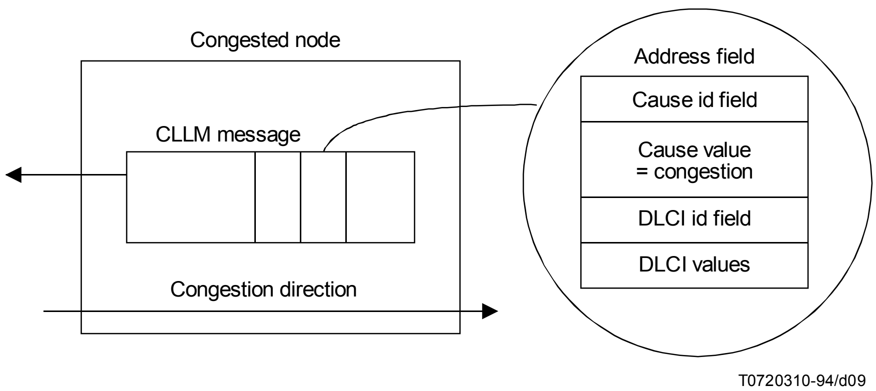


FIGURE C.2/X.36

CLLM message send sequence



NOTE – Timer recovery from cause of CLLM message is a new procedure and is required to be discussed corresponding to SG11.

FIGURE C.3/X.36

Congestion notification using CLLM message

Annex D

Use of frame relay for multiprotocol encapsulation

(This annex forms an integral part of this Recommendation)

This annex provides guidance when using frame relay for the encapsulation of multiple protocols. Multi-protocol encapsulation provides a flexible method for carrying several protocols on a given frame relay connection. The use of these procedures is optional.

Guidance is also provided on using frame relay for the encapsulation of multiple protocols.

D.1 General Frame Format

The format used for multiprotocol encapsulation is described in Figure D.1. It follows the frame format defined in Figure 2.

8 7 6 5 4 3 2 1	
Flag	Octet 1
Address field first octet (Note)	Octet 2
Address field second octet	Octet 3
Control field of UI frame = Hexadecimal 03	Octet 4
Optional PAD = Hexadecimal 00	Octet 5
Protocol Identifier	Octet 6
Encapsulated PDU	Octet N – 3
Frame Check Sequence first octet	Octet N – 2
Frame Check Sequence second octet	Octet N – 1
Flag	Octet N

NOTE – The default address field length is 2 octets. It may be extended to either 3 or 4 octets.

FIGURE D.1/X.36

Frame Format for multiprotocol encapsulation with 2 octets address

The first octet in the information field is the control field of a UI frame with P bit set to 0.

An optional PAD field is used to align the remainder of the frame to a two octet boundary. There may be zero or one pad octet within the pad field and, if present, must have a value of zero.

The protocol identifier field is used to identify the protocol whose PDU is encapsulated in the remainder of the information field.

The protocol identifiers are defined in ISO/IEC TR 9577 (second edition). All users of this Recommendation are encouraged to investigate the possibility of applying the most recent edition of the ISO/IEC TR 9577 (second edition).

Note that when the code point 80 Hexadecimal [for IEEE SNAP (Subnetwork Access Protocols) convention] is used, the protocol identifier octet is extended to six: three additional for the Organizationally Unique Identifier (OUI) and two additional for the protocol identifier. These additional five octets are inserted after the protocol identifier octet and before the encapsulated PDU.

An NLPID value of hexadecimal 00 is invalid for multiprotocol encapsulation in frame relay frames since this value cannot be distinguished from a pad field.

D.2 Frame Format for ISO CLNP (ISO 8473)

The format used for encapsulation of ISO CLNP is described in Figure D.2. The protocol identifier is set to hexadecimal 81.

Note that in the case of ISO CLNP, the protocol identifier is also considered part of the CLNP unit data PDU and as such, it shall be retained.

8 7 6 5 4 3 2 1	
Flag	Octet 1
Address field first octet	Octet 2
Address field second octet	Octet 3
Control field of UI frame = Hexadecimal 03	Octet 4
Protocol Identifier set to Hexadecimal 81	Octet 5
Remainder of CLNP unit data	Octet N – 3
Frame Check Sequence first octet	Octet N – 2
Frame Check Sequence second octet	Octet N – 1
Flag	Octet N

FIGURE D.2/X.36

Encapsulation of CLNP (ISO 8473) unit data PDU

D.3 Frame Format for IP

The format used for encapsulation of IP datagrams is described in Figure D.3. The protocol identifier is set to hexadecimal CC.

D.4 Frame Format for protocols with Ethertype code point

Some protocol have not an assigned protocol identifier code point in ISO/IEC TR 9577 (second edition), but have an Ethertype code point assigned.

The format used for encapsulation of PDUs of such protocols is described in Figure D.4.

The protocol identifier is set to hexadecimal 80 indicating the use of the SNAP convention. The OUI value used for this encapsulation is set to hexadecimal 00-00-00 indicating that the following two octets (PID) contain an Ethertype code point.

8 7 6 5 4 3 2 1	
Flag	Octet 1
Address field first octet	Octet 2
Address field second octet	Octet 3
Control field of UI frame = Hexadecimal 03	Octet 4
Protocol Identifier set to Hexadecimal CC	Octet 5
IP datagram	Octet N – 3
Frame Check Sequence first octet	Octet N – 2
Frame Check Sequence second octet	Octet N – 1
Flag	Octet N

FIGURE D.3/X.36

Encapsulation of an IP datagram

8 7 6 5 4 3 2 1	
Flag	Octet 1
Address field first octet	Octet 2
Address field second octet	Octet 3
Control field of UI frame = Hexadecimal 03	Octet 4
PAD = Hexadecimal 00	Octet 5
Protocol Identifier set to hexadecimal 80	Octet 6
OUI first octet set to hexadecimal 00	Octet 7
OUI second octet set to hexadecimal 00	Octet 8
OUI third octet set to hexadecimal 00	Octet 9
Ethertype first octet	Octet 10
Ethertype second octet	Octet 11
Encapsulated PDU	Octet N – 3
Frame Check Sequence first octet	Octet N – 2
Frame Check Sequence second octet	Octet N – 1
Flag	Octet N

FIGURE D.4/X.36

Encapsulation of protocol identified through Ethertype

D.5 Frame Format for bridged packets

The protocol identifier is set to hexadecimal 80 indicating the use of the SNAP convention. The OUI value used for this encapsulation is the IEEE 802.1 organization code hexadecimal 00 80 C2. The following two octets (PID) specify the form of the MAC header. Additionally, the PID indicates whether the original FCS is preserved within the bridged packet. Table D.1 provides the values of the PID to be used with multiprotocol encapsulation over Frame Relay.

NOTE – In addition the PID value hexadecimal 00 0E, identifies bridged protocol data units Bridged PDUs) as defined by 802.1 (d) or 802.1 (g) (See IEEE, "IEEE Standard for local and Metropolitan Networks : Media Access Control (MAC) Bridges", IEEE Standard 802.1D 1990). The PID value hexadecimal 00 0F identifies source routing Bridged PDU.

TABLE D.1/X.36

PID Values for OUI hexadecimal 00 80 C2

With preserved FCS (Hexadecimal)	Without preserved FCS (Hexadecimal)	Media
00 01	00 07	802.3
00 02	00 08	802.4
00 03	00 09	802.5
00 04	00 0A	FDDI
	00 0B	802.6

D.5.1 Frame Format for bridged 802.3 frame

The format used for encapsulation of bridged 802.3 frame is described in Figure D.5.

8 7 6 5 4 3 2 1	
Flag	Octet 1
Address field first octet	Octet 2
Address field second octet	Octet 3
Control field of UI frame = Hexadecimal 03	Octet 4
PAD = Hexadecimal 00	Octet 5
Protocol Identifier set to hexadecimal 80	Octet 6
OUI first octet set to hexadecimal 00	Octet 7
OUI second octet set to hexadecimal 80	Octet 8
OUI third octet set to hexadecimal C2	Octet 9
PID first octet set to hexadecimal 00	Octet 10
PID second octet set to hexadecimal 01 or 07	Octet 11
MAC destination address (Remainder of the MAC frame)	Octet 12
LAN FCS (If PID second octet is set to hexadecimal 01) (4 octets)	Octet N – 3
Frame Check Sequence first octet	Octet N – 2
Frame Check Sequence second octet	Octet N – 1
Flag	Octet N

FIGURE D.5/X.36

Encapsulation of bridged 802.3 frame

D.5.2 Frame Format for bridged 802.4 frame

The format used for encapsulation of bridged 802.4 frame is described in Figure D.6.

8 7 6 5 4 3 2 1	
Flag	Octet 1
Address field first octet	Octet 2
Address field second octet	Octet 3
Control field of UI frame = Hexadecimal 03	Octet 4
PAD = Hexadecimal 00	Octet 5
Protocol Identifier set to hexadecimal 80	Octet 6
OUI first octet set to hexadecimal 00	Octet 7
OUI second octet set to hexadecimal 80	Octet 8
OUI third octet set to hexadecimal C2	Octet 9
PID first octet set to hexadecimal 00	Octet 10
PID second octet set to hexadecimal 02 or 08	Octet 11
PAD = Hexadecimal 00	Octet 12
Frame Control	Octet 13
MAC destination address (Remainder of the MAC frame)	Octet 14
LAN FCS (If PID second octet is set to hexadecimal 02) (4 octets)	Octet N – 3
Frame Check Sequence first octet	Octet N – 2
Frame Check Sequence second octet	Octet N – 1
Flag	Octet N

FIGURE D.6/X.36

Encapsulation of bridged 802.4 frame

D.5.3 Frame Format for bridged 802.5 frame

The format used for encapsulation of bridged 802.5 frame is described in Figure D.7.

D.5.4 Frame Format for bridged FDDI frame

The format used for encapsulation of bridged FDDI frame is described in Figure D.8.

D.5.5 Frame Format for bridged 802.6 frame

The format used for encapsulation of bridged 802.6 frame is described in Figure D.9.

The common Protocol Data Unit (PDU) header and trailer are conveyed to allow pipe lining at the egress bridge to an 802.6 subnetwork. Specifically, the common PDU header contains the BAsize field, which contains the length of the PDU. If this field is not available to the egress 802.6 bridge, then that bridge cannot begin to transmit the segmented PDU until it has received the entire PDU, calculated the length, and inserted the length into the BAsize field. If the field is available, the egress 802.6 bridge can extract the length from the BAsize field of the common PDU header, insert it into the corresponding field of the first segment, and immediately transmit the segment onto the 802.6 subnetwork. Thus, the bridge can begin transmitting the 802.6 PDU before it has received the complete PDU.

The common PDU header and trailer of the encapsulated frame should not be simply copied to the outgoing 802.6 subnetwork because the encapsulated BEtag value may conflict with the previous BEtag value transmitted by that bridge.

D.5.6 Frame Format for Bridged PDU

The format used for encapsulation of Bridged PDU is described in Figure D.10.

D.5.7 Frame Format for Source Routing Bridged PDU

The format used for encapsulation of Source Routing Bridged PDU is described in Figure D.11.

8 7 6 5 4 3 2 1	
Flag	Octet 1
Address field first octet	Octet 2
Address field second octet	Octet 3
Control field of UI frame = Hexadecimal 03	Octet 4
PAD = Hexadecimal 00	Octet 5
Protocol Identifier set to hexadecimal 80	Octet 6
OUI first octet set to hexadecimal 00	Octet 7
OUI second octet set to hexadecimal 80	Octet 8
OUI third octet set to hexadecimal C2	Octet 9
PID first octet set to hexadecimal 00	Octet 10
PID second octet set to hexadecimal 03 or 09	Octet 11
PAD = Hexadecimal 00	Octet 12
Frame Control	Octet 13
MAC destination address (Remainder of the MAC frame)	Octet 14
LAN FCS (If PID second octet is set to hexadecimal 03) (4 octets)	Octet N – 3
Frame Check Sequence first octet	Octet N – 2
Frame Check Sequence second octet	Octet N – 1
Flag	Octet N

FIGURE D.7/X.36

Encapsulation of bridged 802.5 frame

8 7 6 5 4 3 2 1	
Flag	Octet 1
Address field first octet	Octet 2
Address field second octet	Octet 3
Control field of UI frame = Hexadecimal 03	Octet 4
PAD = Hexadecimal 00	Octet 5
Protocol Identifier set to hexadecimal 80	Octet 6
OUI first octet set to hexadecimal 00	Octet 7
OUI second octet set to hexadecimal 80	Octet 8
OUI third octet set to hexadecimal C2	Octet 9
PID first octet set to hexadecimal 00	Octet 10
PID second octet set to hexadecimal 04 or 0A	Octet 11
PAD = Hexadecimal 00	Octet 12
Frame Control	Octet 13
MAC destination address (Remainder of the MAC frame)	Octet 14
LAN FCS (If PID second octet is set to hexadecimal 04) (4 octets)	Octet N – 3
Frame Check Sequence first fctet	Octet N – 2
Frame Check Sequence second octet	Octet N – 1
Flag	Octet N

FIGURE D.8/X.36

Encapsulation of bridged FDDI frame

8 7 6 5 4 3 2 1	
Flag	Octet 1
Address field first octet	Octet 2
Address field second octet	Octet 3
Control field of UI frame = Hexadecimal 03	Octet 4
PAD = Hexadecimal 00	Octet 5
Protocol Identifier set to hexadecimal 80	Octet 6
OUI first octet set to hexadecimal 00	Octet 7
OUI second octet set to hexadecimal 80	Octet 8
OUI third octet set to hexadecimal C2	Octet 9
PID first octet set to hexadecimal 00	Octet 10
PID second octet set to hexadecimal 0B (Note)	Octet 11
Reserved	Octet 12
BEtag	Octet 13
BAsize	Octet 14
BAsize (continue)	Octet 15
MAC destination address (Remainder of the MAC frame)	Octet 16
Common PDU trailer (4 octets)	Octet N – 3
Frame Check Sequence first octet	Octet N – 2
Frame Check Sequence second octet	Octet N – 1
Flag	Octet N

NOTE – In bridged 802.6 PDUs, there is only one choice for the PID value, since the presence of a CRC 32 is identified by the CIB bit in the header of the MAC frame.

FIGURE D.9/X.36

Encapsulation of bridged 802.6 frame

8 7 6 5 4 3 2 1	
Flag	Octet 1
Address field first octet	Octet 2
Address field second octet	Octet 3
Control field of UI frame = Hexadecimal 03	Octet 4
PAD = Hexadecimal 00	Octet 5
Protocol Identifier set to hexadecimal 80	Octet 6
OUI first octet set to hexadecimal 00	Octet 7
OUI second octet set to hexadecimal 80	Octet 8
OUI third octet set to hexadecimal C2	Octet 9
PID first octet set to hexadecimal 00	Octet 10
PID second octet set to hexadecimal 0E	Octet 11
Bridged PDU as defined by 802.1(d) or 802.1 (g)	Octet 12 Octet N – 3
Frame Check Sequence first octet	Octet N – 2
Frame Check Sequence second octet	Octet N – 1
Flag	Octet N

FIGURE D.10/X.36

Encapsulation of Bridged PDU

8 7 6 5 4 3 2 1	
Flag	Octet 1
Address field first octet	Octet 2
Address field second octet	Octet 3
Control field of UI frame = Hexadecimal 03	Octet 4
PAD = Hexadecimal 00	Octet 5
Protocol Identifier set to hexadecimal 80	Octet 6
OUI first octet set to hexadecimal 00	Octet 7
OUI second octet set to hexadecimal 80	Octet 8
OUI third octet set to hexadecimal C2	Octet 9
PID first octet set to hexadecimal 00	Octet 10
PID second octet set to hexadecimal 0F	Octet 11
Source Routing Bridged PDU	Octet 12 Octet N – 3
Frame Check Sequence first octet	Octet N – 2
Frame Check Sequence second octet	Octet N – 1
Flag	Octet N

FIGURE D.11/X.36

Encapsulation of Source Routing Bridged PDU

Appendix I

Examples of PVC management error events

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

I.1 Loss of STATUS ENQUIRY message

The loss of a STATUS ENQUIRY message may be due to failure on the DTE/DCE interface. When STATUS ENQUIRY message is lost, T392 expires and the DCE counts an error event.

Since no STATUS message is transmitted by the DCE in such a case, T391 expires and the DTE counts an error event (see Figure I.1).

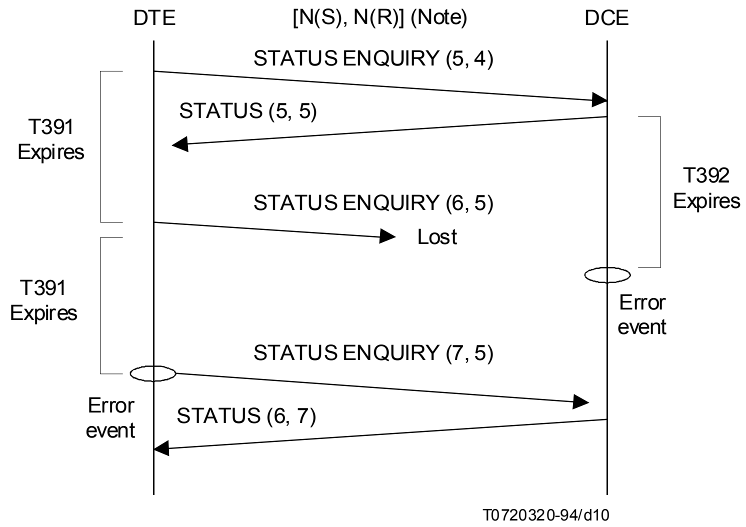
I.2 Loss of STATUS message

The loss of a STATUS message may be due to a DTE/DCE interface failure. When the STATUS message is lost, T391 expires and the DTE counts an error event. The DTE transmit a new STATUS ENQUIRY message. Upon reception of this STATUS ENQUIRY message, the DCE counts an error event since its last send sequence number is not equal to the receive sequence number contained in the STATUS ENQUIRY message (see Figure I.2).

I.3 Invalid Receive Sequence Number

The DTE or DCE checks the Receive Sequence Number in a STATUS/STATUS ENQUIRY message. In the case that the Receive Sequence Number in a STATUS/STATUS ENQUIRY is not equal to the last Send Sequence Number, the DTE or DCE counts an Error on the PVC management procedure.

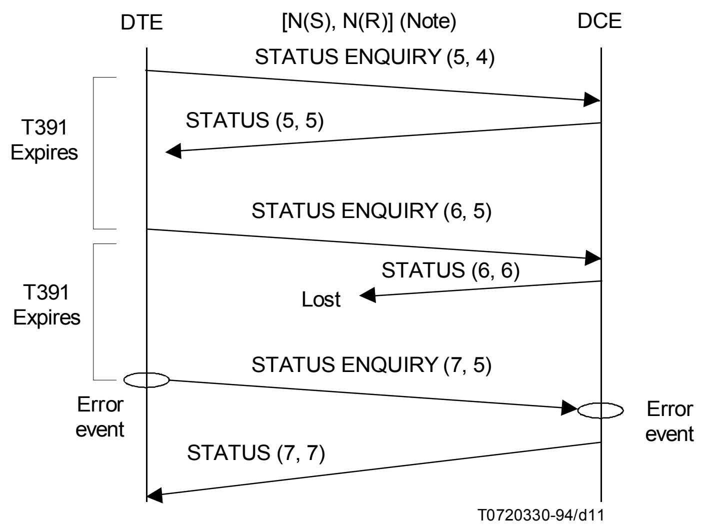
In case of DTE/DCE failure or internal data reset, Send Sequence counter or Receive Sequence counter may be modified, causing an error event to be counted during next cycle.



NOTE – For each STATUS message and STATUS ENQUIRY message (,) stands for sequence number [N(S), N(R)] sent in those messages.

FIGURE I.1/X.36

Error event by Status Enquiry message loss



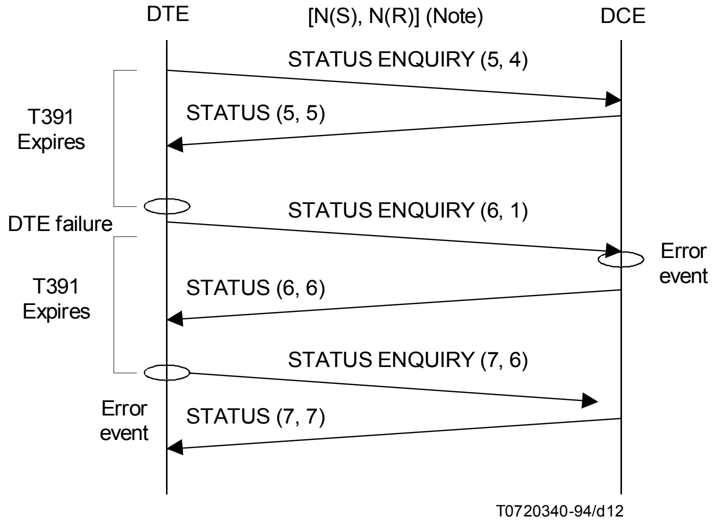
NOTE – For each STATUS message and STATUS ENQUIRY message (,) stands for sequence number [N(S), N(R)] sent in those messages.

FIGURE I.2/X.36

Error event by Status message loss

Figure I.3 shows an error event of the Receive Sequence Number in a STATUS ENQUIRY message.

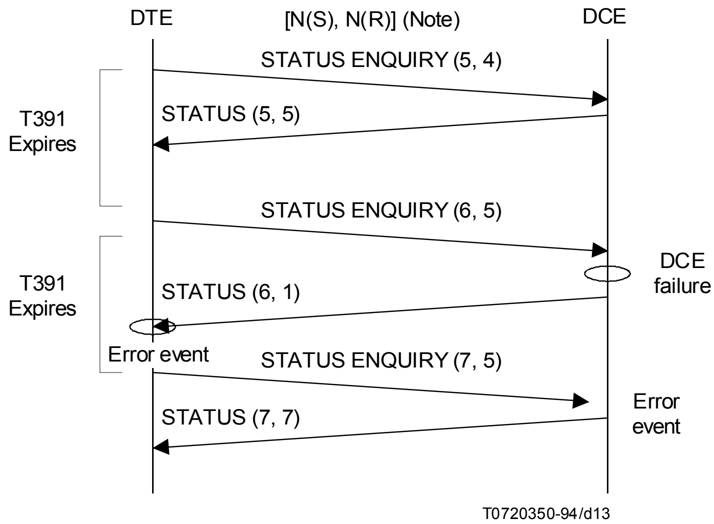
Figure I.4 shows an error event of the Receive Sequence Number in a STATUS message.



NOTE – For each STATUS message and STATUS ENQUIRY message (,) stands for sequence number [N(S), N(R)] sent in those messages.

FIGURE I.3/X.36

Error event by Receive Sequence Number error in STATUS ENQUIRY message



NOTE – For each STATUS message and STATUS ENQUIRY message (,) stands for sequence number [N(S), N(R)] sent in those messages.

FIGURE I.4/X.36

Error event by Receive Sequence Number error in STATUS message

Appendix II

DTE congestion detection methods and actions

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

The DTE may detect network congestion either through implicit or explicit detection. This appendix describes the methods used by the DTE to detect network congestion and the recommended action to be taken by the DTE at such times of congestion. More detailed information can be found in Appendix I/Q.922.

II.1 Implicit congestion detection

The DTE have the capability of automatically detecting congestion without receiving explicit congestion notification from the network. When the network becomes heavily congested, there is a high probability that frames will be discarded. Thus, to avoid frame loss, the DTE should recognize congestion has occurred in the network when it detects the number to percentage of discarded frames exceeds a specified threshold. Examples of methods which might be used to detect congestion include the assignment of sequence numbers to frames by the upper-level protocol or the use of the layer 2 procedure (e.g. timer or REJ frame) for use in detecting missing frames. The process whereby the DTE automatically detect a state of congestion without receiving notification of the congestion from the network is known as implicit congestion detection. When a state of congestion has been implicitly detected, the DTE must reduce the traffic to the network to control the overall flow. More information of the method of control can be found in Appendix I/Q.922.

II.2 Explicit congestion detection

At times of congestion, the network may use the BECN/FECN bits setting or CLLM message to inform the DTEs of the state of congestion, and require the DTE to reduce the traffic. At times of congestion the network may attempt to avoid further congestion by requesting the DTEs to reduce the traffic to the network. Continued congestion may result in the discarding of frames which will influence the communications quality.

Appendix III

Comparison between X.36 and Q-Series/I-Series Recommendations

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

This appendix provides a clause-by-clause comparison between this Recommendation and the relevant Q-Series/I-Series Recommendations. The comparison is provided in a tabular form (see Table III.1).

1) The first column indicates the clause number of this Recommendation.

2) The second column indicates the relevant clause of the corresponding Q-Series/I-Series Recommendations.

3) The third column indicates if the two corresponding clauses are technically aligned. A “Yes” entry indicates that they are technically aligned. A “No” entry indicates that they are not technically aligned. A brief description of the technical difference is provided under the column labeled “Comments.” An “Identical” entry indicates that the corresponding clauses are identical. An “N/A” entry indicates that the comparison is not applicable and the reason is given under the column labeled “Comments.”

4) The fourth column indicates if the two corresponding clauses are editorially aligned. An “Identical” entry indicates that the corresponding clauses are identical. A “No” entry indicates that the corresponding clauses are not editorially aligned. An “N/A” entry indicates that the comparison is not applicable.

At the time of publication of this Recommendation, the following editions of the Q-Series/I-Series Recommendations are valid:

– Recommendation Q.922 (1992).

– Recommendation Q.933 (1993). Expected changes to this edition of Recommendation Q.933 are marked in the tables.

– Recommendation I.370 (1991).

TABLE III.1/X.36 (sheet 1 of 4)

Comparison between X.36 and Q-Series/I-Series Recommendations

X.36		Q-Series/I-Series	Technically aligned	Editorially aligned	Comments
Clause 1	Scope		N/A	N/A	Specific to X.36
Clause 2	References		N/A	N/A	Specific to X.36
Clause 3	Terms and definitions		N/A	N/A	Specific to X.36
Clause 4	Abbreviations		N/A	N/A	Specific to X.36
Clause 5	Conventions		N/A	N/A	Specific to X.36
Clause 6	Description of the DTE/DCE interface (physical layer)		N/A	N/A	The text in this clause provides the relevant pointers to other Recommendations.
Clause 7	Description of services				Specific to X.36
Clause 8	Service parameters and Service quality				
8.1	Scope		N/A	N/A	Specific to X.36
8.2	Service parameters				
8.2.1	Access rate	1.2/I.370	Yes	Yes	
8.2.2	Committed burst size	1.2/I.370	Yes	Yes	
8.2.3	Excess burst size	1.2/I.370	Yes	Yes	
8.2.4	Committed information rate	1.2/I.370	Yes	Yes	
8.2.5	Committed rate measurement interval	1.2/I.370	Yes	Yes	
8.2.6	Maximum octet length of frame relay information field (N203)	A.5.1/Q.922	No	No	X.36 allows a zero length Information field. The minimum length of the Information field in Q.922 is one octet.
8.3	Service quality	See comment	N/A	N/A	No corresponding explicit text

TABLE III.1/X.36 (sheet 2 of 4)

Comparison between X.36 and Q-Series/I-Series Recommendations

X.36		Q-Series/I-Series	Technically aligned	Editorially aligned	Comments
Clause 9	Data link transfer control				
9.1	General	A.1/Q.922	Yes	Yes	
9.2	Frame format	Figure A.1/Q.922	Yes	Yes	
9.2.1	Flag sequence	A.2.2/Q.922	Yes	Yes	
9.2.2	Address field	A.2.3/Q.922	Yes	Yes	
9.2.3	Information field	A.2.5/Q.922	Identical	Identical	
9.2.4	Frame check sequence (FCS) field	A.2.7/Q.922	Identical	Identical	
9.3	Addressing				
9.3.1	General	See comment	N/A	N/A	No corresponding explicit text
9.3.2	Address field format	A.3.2/Q.922	Yes	Yes	
9.3.3	The address field element				
9.3.3.1	Address field extension bit	A.3.3.1/Q.922	Yes	Yes	
9.3.3.2	Command/response bit	A.3.3.2/Q.922	Yes	Yes	
9.3.3.3	Forward explicit congestion notification bit	A.3.3.3/Q.922	Yes	Yes	
9.3.3.4	Backward explicit congestion notification bit	A.3.3.4/Q.922	Yes	Yes	
9.3.3.5	Discard eligibility indicator bit	A.3.3.5/Q.922	Yes	Yes	
9.3.3.6	Data link connection identifier and Tables 1-1, 1-2 and 1-3	A.3.3.6/Q.922 Table 1/Q.922	No		Q.922 provides a network option to support a certain range of DLCIs for user information on non-D-channels. X.36 always allows this range of DLCIs to be used.
9.3.3.7	DLCI extension/Control indication bit (D/C bit)	Q.922/A.3.3.7	Yes	Yes	
9.4	Transmission consideration				
9.4.1	Order of bit transmission	See comment	N/A	N/A	No corresponding explicit text
9.4.2	Order of bits in frame fields	See comment	N/A	N/A	No corresponding explicit text
9.4.3	Transparency	A.2.6/Q.922	Yes	Yes	
9.4.4	Inter frame fill	2.2/Q.922	Yes	Yes	
9.4.5	Invalid frame	A.2.9/Q.922	No	No	Differences due to 8.2.6/X.36 differences
9.4.6	Frame abortion	See comment	N/A	N/A	No corresponding explicit text

TABLE III.1/X.36 (sheet 3 of 4)

Comparison between X.36 and Q-Series/I-Series Recommendations

X.36		Q-Series/I-Series	Technically aligned	Editorially aligned	Comments
Clause 10	Call connection control	Q.933	No	N/A	For further study in X.36
Clause 11	PVC management procedures				
11.1	Overview	Annex A/Q.933	No	No	The support of these procedures is mandatory for the network and is a subscription option for the DTE per X.36. The support of these procedures is mandatory for both per Annex A/Q.933.
11.2	Message definition	See comment	Yes	N/A	No corresponding explicit text
11.2.1	STATUS ENQUIRY message	A.1.2/Q.933	Yes	Yes	
11.2.2	STATUS message	A.1.1/Q.933	Yes	Yes	
11.3	Message specific information elements	A.2/Q.933			
11.3.1	Message type	4.4/Q.933	Yes	Yes	
11.3.2	Report type	A.3.1/Q.933	Yes	Yes	
11.3.3	Link integrity verification	A.3.2/Q.933	Yes	Yes	
11.3.4	PVC status	A.3.3/Q.933	Yes	No	The Delete bit (D-bit) is included in X.36. It is expected to include the D-bit in Q.933.
11.4	Description of procedures	A.4/Q.933	Yes	Yes	
11.4.1	Periodic polling				
11.4.1.1	General	A.4.1/Q.933	Yes	Yes	
11.4.1.2	Link integrity verification	A.4.2/Q.933	Yes	Yes	
11.4.1.3	Signalling of the presence or absence of a PVC	See comment	Yes	N/A	No corresponding explicit text
11.4.1.4	Signalling that a PVC is new	A.4.3/Q.933	Yes	No	
11.4.1.5	Signalling the activity status of PVCs	A.4.4/Q.933	Yes	No	
11.4.1.6	Error monitoring	A.5/Q.933	Yes	No	
11.4.1.6.1	DCE actions	A.5.1/Q.933	Yes	No	
11.4.1.6.2	DTE actions	A.5.2/Q.933	Yes	No	
11.4.2	Asynchronous PVC STATUS message		Yes	No	Differences due to the diffeences in 11.3.4/X.36. Alignment will be achieved when D-bit will be included in Q.933.
11.5	Optional bidirectional network procedures	A.6/Q.933	Yes	No	
11.6	System parameters	A.7/Q.933	Yes	No	
Clause 12	Congestion control	Annex A/I.370 and Annex A/Q.922	Yes	No	

TABLE III.1/X.36 (sheet 4 of 4)

Comparison between X.36 and Q-Series/I-Series Recommendations

X.36	Q-Series/I-Series	Technically aligned	Editorially aligned	Comments
Annex A – List and status of the X.36 parameters	See comment	N/A	No	No corresponding explicit text
Annex B – Functional support at the DTE/DCE interface	No corresponding explict text	No	No	The support of these procedures is mandatory for the network and is a subscription option for the DTE per X.36. The support of these procedures is mandatory per Annex A/Q.933.
Annex C – Consolidated link layer management (CLLM) message	A.7/Q.922	Yes	No	
C.1 Address octets	A.7.1/Q.922	Yes	No	
C.2 Control field	A.7.2/Q.922	Identical	Identical	
C.3 XID information field	A.7.3/Q.922	Yes	No	
C.3.5 DLCI identifier parameter field	A.7.3.5/Q.922	Identical	Identical	
C.4 FCS field	A.7.4/Q.922	Identical	Identical	
C.5 Network CLLM message transmission procedure	A.6.2.1/Q.922 A.7.5/I.370	Yes	No	No corresponding explicit text
C.5.1 Network congestion		Yes	No	No corresponding explicit text
C.5.2 Network failure		N/A	N/A	No corresponding explicit text
C.5.3 Notification of network maintenance action		N/A	N/A	No corresponding explicit text
C.5.4 Recovery from cause given in the CLLM message		No	No	These procedures are not specified in A.7/Q.922.
Annex D – Multiprotocol encapsulation	Annex F/Q.933	No	No	The encapsulation using I frames, described in F.4.2/Q.933, is not specified in X.36. The procedures, to support fragmentation and reassembly of encapsulated frames described in F.5.3/Q.933, are not specified in X.36.
D.1 General Frame Format	F.2/Q.933	Yes	No	
D.2 Frame Format for ISO CLNP (ISO 8473)	F.4.1.1/Q.933	Yes	No	
D.3 Frame Format for IP	F.4.1.2/Q.933	Yes	No	
D.4 Frame Format for protocols with Ethertype code point	F.5.1/Q.933	No	No	The encapsulation of protocols that have been assigned an NLPID, described in Figure F.12/Q.933, is not specified in X.36.
D.5 Frame Format for bridged packets	F.5.2/Q.933	Yes	No	
Appendix I – Examples of PVC management error events	See comment	N/A		No corresponding text