EUROPEAN **T**ELECOMMUNICATION **S**TANDARD

ETS 300 402-3

August 1996

Source: ETSI TC-SPS

Reference: DE/SPS-05030-1

ICS: 33.080, 35.100.20

Key words: ISDN, DSS1, layer 2, D-channel, LAPF

Integrated Services Digital Network (ISDN); Digital Subscriber Signalling System No. one (DSS1) protocol; Data link layer; Part 3: Frame relay protocol specification

ETSI

European Telecommunications Standards Institute

ETSI Secretariat

Postal address: F-06921 Sophia Antipolis CEDEX - FRANCE
Office address: 650 Route des Lucioles - Sophia Antipolis - Valbonne - FRANCE
X.400: c=fr, a=atlas, p=etsi, s=secretariat - **Internet:** secretariat@etsi.fr

Tel.: +33 92 94 42 00 - Fax: +33 93 65 47 16

Contents

Foreword

This European Telecommunication Standard (ETS) has been produced by the Signalling Protocols and Switching (SPS) Technical Committee of the European Telecommunications Standards Institute (ETSI).

This ETS is based on CCITT Recommendation Q.922 (1992) and provides modifications and further requirements.

This ETS is part 3 of a multi-part standard covering the Integrated Services Digital Network (ISDN) Digital Subscriber Signalling System No. one (DSS1) data link layer specification as described below:

Part 1: "General aspects [ITU-T Recommendation Q.920 (1993), modified]";

Part 2: "General protocol specification [ITU-T Recommendation Q.921 (1993), modified]";

Part 3: "Frame relay protocol specification";

Part 4: "Protocol Implementation Conformance Statement (PICS) proforma specification for the general protocol";

Part 5: "PICS proforma specification for the frame relay protocol";

Part 6: "Test Suite Structure and Test Purposes (TSS&TP) specification for the general protocol";

Part 7: "Abstract Test Suite (ATS) and partial Protocol Implementation eXtra Information for Testing (PIXIT) proforma specification for the general protocol".

Transposition dates	
Date of adoption of this ETS:	16 August 1996
Date of latest announcement of this ETS (doa):	30 November 1996
Date of latest publication of new National Standard or endorsement of this ETS (dop/e):	31 May 1997
Date of withdrawal of any conflicting National Standard (dow):	31 May 1997

Blank page

1 Scope

This third part of ETS 300 402 specifies the frame structure, elements of procedure, format of fields and procedures for the proper operation of the Frame Relay layer 2 protocol as described in the service description ETS 300 399-1 [1].

NOTE 1: The Frame Relay protocol as defined in this ETS may be used with or without the elements of procedures of Link Access Procedure for Frame mode bearer services (LAPF) in CCITT Recommendation Q.922 [8].

LAPF as defined in CCITT Recommendation Q.922 [8] designates the link access procedures applicable to, but not restricted to, the Frame Relay service. The protocol specified in this ETS is a subset of LAPF; it is named "Data Link Core protocol" (DL-CORE) and it is used to support the Frame Relay service. It is intended to:

- share the core functions of LAPF as defined in ITU-T Recommendation I.233 [5];
- be used on B- or D-channel or n × 64 kbit/s; and
- operate on the D-channel simultaneously with the Link Access Procedure on the D-channel (LAPD) protocol as defined in ITU-T Recommendations Q.920 and Q.921 as modified by ETS 300 402-1 [2] and ETS 300 402-2 [3].

It assumes that data link identification is determined via group signalling or by prior agreement.

NOTE 2: Group signalling is defined in appendix II of CCITT Recommendation Q.922 [8].

The functions of DL-CORE, used to support the Frame Relay service, are considered to be:

- frame delimiting, alignment and transparency;
- frame multiplexing/demultiplexing 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; and
- congestion control functions.

2 Normative references

This ETS incorporates by dated and undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this ETS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] ETS 300 399-1 (1995): "Frame relay services; Part 1: General description".

[2] ETS 300 402-1: "Integrated Services Digital Network (ISDN); Digital Subscriber Signalling System No. one (DSS1) protocol; Data link layer; Part 1: General aspects [ITU-T Recommendation Q.920 (1993), modified]".

[3] ETS 300 402-2: "Integrated Services Digital Network (ISDN); Digital Subscriber Signalling System No. one (DSS1) protocol; Data link layer; Part 2: General protocol specification [ITU-T Recommendation Q.921 (1993), modified]".

[4] ITU-T Recommendation I.122 (1993): "Framework for frame bearer services".

[5] ITU-T Recommendation I.233 (1993): "Frame mode bearer service".

[6] ITU-T Recommendation I.320 (1993): "ISDN protocol reference model".

[7] CCITT Recommendation I.370 (1991): "Congestion management for the ISDN frame relaying bearer service".

[8] CCITT Recommendation Q.922 (1992): "ISDN data link layer specification for frame mode bearer services".

[9] ITU-T Recommendation X.200 (1994) | ISO/IEC 7498-1 (1994): "Information technology - Open Systems Interconnection - Basic reference model: The basic model".

[10] ITU-T Recommendation X.210 (1993) | ISO/IEC 10731 (1994): "Information technology - Open systems interconnection - Basic reference model: Conventions for the definitions of OSI services".

[11] CCITT Recommendation X.211 (1988): "Physical service definition of open systems interconnection for CCITT applications".

[12] ISO/IEC 8885 (1993): "Information technology - Telecommunications and information exchange between systems - High-level data link control (HDLC) procedures - General purpose XID frame information field content and format".

3 Abbreviations

For the purposes of this ETS, the following abbreviations apply:

BECN	Backward Explicit Congestion Notification
C-plane	Control plane
C/R	Command/Response field bit
CEI	Connection Endpoint Identifier
CLLM	Consolidated Link Layer Management
D/C	DLCI or DL-CORE control indicator
DE	Discard Eligibility indicator
DL	Data Link (layer)
DL-	communication between layer 3 and data link layer
DL-CORE	Data Link Core protocol
DL-CORE-	communication between the DL-CORE user and DL-CORE
DLCI	Data Link Connection Identifier
EA	Address field Extension bit
FECN	Forward Explicit Congestion Notification
FCS	Frame Check Sequence
HDLC	High-level Data Link Control
ISDN	Integrated Services Digital Network
LAN	Local Area Network
LAPD	Link Access Procedure on the D-channel
LAPF	Link Access Procedure for Frame mode bearer services
M2N-	communication between layer 3 and layer 2 management entities
MC-	communication between DL-CORE and layer 2 management
MDL-	communication between layer 2 management and data link layer
OSI	Open Systems Interconnection
PH	Physical (layer)
PH-	communication between data link layer and physical layer
PDU	Protocol Data Unit
SAP	Service Access Point
SAPI	Service Access Point Identifier
TEI	Terminal Endpoint Identifier
U-plane	User plane
XID	eXchange IDentification

4 Frame structure for peer-to-peer communication

4.1 General

All data link layer peer-to-peer exchanges are in frames conforming to the format shown in figure 1 (other 3 or 4 octet address formats are available).

Bits 8	7	6	5	4	3	2	1	Octet
Flag								1
0	1	1	1	1	1	1	0	
high order octet of address field								2
low order octet of address field								3
								4
Frame Relay Information field								
								N-3
FCS 1st octet								N-2
FCS 2nd octet								N-1
Flag								
0	1	1	1	1	1	1	0	N

Figure 1: Frame Relay frame format with two octet address

4.2 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. The closing flag may also serve as the opening flag of the next frame, in some applications. However, all receivers shall be able to accommodate receipt of one or more consecutive flags.

Flags shall be used as interframe fill (on channels other than D-channels).

4.3 Address field

The address field shall consist of at least two octets as illustrated in figure 1 but may optionally be extended up to 4 octets. The format of the address field is defined in subclause 5.2.

4.4 Control field

A control field, as seen by the DL-CORE sublayer, does not exist in a Frame Relay frame structure.

4.5 Frame Relay information field

The Frame Relay information field of a frame, when present, follows the address field (see subclause 5.2) and precedes the frame check sequence field (see subclause 4.7). The contents of the Frame Relay information field shall consist of an integral number of octets.

The maximum number of octets in the Frame Relay information field is defined in clause 7.

4.6 Transparency

A transmitting data link layer entity shall examine the frame content 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. A receiving data link layer entity 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.

4.7 Frame Checking Sequence (FCS) field

The definition and use of the FCS is specified in subclause 2.7 of ITU-T Recommendation Q.921 as modified by ETS 300 402-2 [3].

4.8 Format convention

The definition of formats and numbering conventions is specified in subclause 2.8 of ITU-T Recommendation Q.921 as modified by ETS 300 402-2 [3].

4.9 Invalid frames

An invalid frame is a frame which:

a) is not properly bounded by two flags; or

b) has fewer than three octets between the address field (as defined in subclause 5.2) and the closing flag; or

c) does not consist of an integral number of octets prior to "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 an address field too long i.e. the extension address (EA) bit set to "0" instead of "1" in the last octet of the address; or

f) contains a Data Link Connection Identifier (DLCI) which is not supported by the receiver.

Invalid frames shall be discarded without notification to the sender. No action is taken as the result of invalid frames.

If a frame which is too long is received by the network, the network may:

- discard the frame (see note); or

- send the complete frame toward the destination user with a valid FCS.

NOTE: This approach implies that the implementation of the Frame Relay protocol cannot exploit the capabilities to discriminate among corrupted or too long frames.

Selection of one or more of these behaviour is an option for designers of Frame Relay network equipment and is not subject to further standardization. Users shall not make any assumption as to which of these actions the network will take. In addition, the network may optionally clear the Frame Relay call if the number or frequency of too long frames exceeds a network specified threshold.

4.10 Frame abort

The definition of and the reaction to frame aborts is specified in subclause 2.10 of ITU-T Recommendation Q.921 as modified by ETS 300 402-2 [3].

5 Elements of procedures and formats of fields for the DL-CORE services sublayer

5.1 General

The elements of procedures contained in this ETS are used by the DL-CORE service sublayer to implement optional procedures for congestion management which are found in clause 8.

5.2 Address field format

The format of the address field is shown in figure 2. This field includes the address field extension bits, a bit reserved for use by end user equipment intended to support a command/response indication, forward and backward congestion notification bits, discard eligibility indication, an indicator for DLCI or DL-CORE control interpretation of a 3 or 4 octet "address field" and a DLCI field. The minimum and default length of the address field is 2 octets and it may be extended to 3 or 4 octets to support a larger DLCI address range or to support the optional DL-CORE control functions. The 3 octet or 4 octet address field formats may be supported at the user-network interface or the network-network interface based on bilateral agreement.

In each channel, the frames shall have the same length for the address field.

Default Address Field Format (2 octets)

<table>
<tr><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th></tr>
<tr><td colspan="6">(upper DLCI)</td><td>*</td><td>EA
0</td></tr>
<tr><td colspan="4">(lower DLCI)</td><td>FECN</td><td>BECN</td><td>DE</td><td>EA
1</td></tr>
</table>

or

3 octet Address Field Format

<table>
<tr><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th></tr>
<tr><td colspan="6">(upper DLCI)</td><td>*</td><td>EA
0</td></tr>
<tr><td colspan="4">DLCI</td><td>FECN</td><td>BECN</td><td>DE</td><td>EA
0</td></tr>
<tr><td colspan="6">(lower DLCI) or
DL-CORE control</td><td>D/C</td><td>EA
1</td></tr>
</table>

or

4 octet Address Field Format

<table>
<tr><th>8</th><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th></tr>
<tr><td colspan="6">(upper DLCI)</td><td>*</td><td>EA
0</td></tr>
<tr><td colspan="4">DLCI</td><td>FECN</td><td>BECN</td><td>DE</td><td>EA
0</td></tr>
<tr><td colspan="7">DLCI</td><td>EA
0</td></tr>
<tr><td colspan="6">(lower DLCI) or
DL-CORE control</td><td>D/C</td><td>EA
1</td></tr>
</table>

D/C = DLCI or DL-CORE control indicator (see subclause 5.3.7)
DE = Discard Eligibility Indicator (see subclause 5.3.5)
EA = Address Field Extension Bit (see subclause 5.3.1)
* = Bit intended to support a command/response indication. The coding is application specific (see subclause 5.3.2)
FECN = Forward Explicit Congestion Notification (see subclause 5.3.3)
BECN = Backward Explicit Congestion Notification (see subclause 5.3.4)
DLCI = Data Link Connection Identifier (see subclause 5.3.6)

Figure 2: Address field format

5.3 Address field variables

5.3.1 Address field extension bit (EA)

The address field range is extended by reserving the first transmitted bit of the address field octets to indicate the final octet of the address field. The presence of a "0" in the first bit of an address field octet signals that another octet of the address follows this one. The presence of a "1" in the first bit of an address field octet signals that it is the final octet of the address field. For example, the two octet address field has bit one of the first octet set to "0" and bit one of the second octet set to "1".

5.3.2 Command/Response bit (C/R)

The C/R bit is not used by the DL-CORE protocol. The coding is application specific. The C/R bit is conveyed transparently by the DL-CORE protocol between DL-CORE services users.

5.3.3 Forward Explicit Congestion Notification (FECN)

This bit may be set by a congested network to notify the user 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 end-system that the frames it receives have encountered congested resources. This bit may be used by destination controlled transmitter rate adjustment.

While setting this bit by the network or user is optional, no network shall ever clear (set to "0") this bit. Networks that do not provide FECN shall pass this bit unchanged. An example of the use of this bit is contained in appendix I of CCITT Recommendation Q.922 [8].

5.3.4 Backward Explicit Congestion Notification (BECN)

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

While setting this bit by the network or user is optional, no network shall ever clear (set to "0") this bit. Networks that do not provide BECN shall pass this bit unchanged. An example of the use of this bit is contained in appendix I of CCITT Recommendation Q.922 [8].

5.3.5 Discard Eligibility indicator (DE)

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 user is optional. No network shall ever clear (i.e. set to "0") this bit. Networks that do not provide DE shall pass this bit unchanged. Networks are not constrained to discard only frames with DE = 1 in the presence of congestion.

5.3.6 Data Link Connection Identifier (DLCI)

The DLCI identifies a virtual connection on a channel (e.g. D-channel, B-channel, or n × 64 kbit/s) at a user-network interface. In consequence, a DLCI specifies a Core data link layer entity to/from which information is delivered/received and which is to be carried in frames by data link layer entities. The DLCI field may be either unstructured or structured. In the former case, the least significant bit is determined as shown in table 1.

Table 1: Least significant bit determination

Address field size	D/C = 0	D/C = 1
2 octets	see note	see note
3 octets	bit 3 of octet 3	bit 5 of octet 2
4 octets	bit 3 of octet 4	bit 2 of octet 3
NOTE: Not applicable; least significant DLCI bit is bit 5 of octet 2.		

A structure to the DLCI field may be established by the network at the user to network interface subject to negotiation or bilateral agreement.

For notation purposes, the six most significant bits (bits 8 to 3) in the first octet of the address field are referred to as the upper DLCI.

The DLCI has a default length of 10 bits. The extension bit may be used to optionally increase the length to 16 bits or 17 bits or 23 bits, as shown in figure 2.

Table 2 shows the ranges of DLCI values which apply for specific functions to ensure compatibility. As described in subclause 5.3.7, the D/C indication may affect the length of the DLCI.

Table 2: Use of DLCIs

DLCI range	Function
10 bit DLCIs (note 1)	
0 (note 2)	In channel signalling, if required
1 - 15	Reserved
16 - 511	On non D-channel, available for support of user information
512 - 991	Logical link identification for support of user information
992 - 1 007	Layer 2 management of Frame Relay service
1 008 - 1 022	Reserved
1 023 (note 2)	In channel layer 2 management, if required
16 bit DLCIs (note 3)	
0 (note 2)	In channel signalling, if required
1 - 1 023	Reserved
1 024 - 32 767	On non D-channel, available for support of user information
32 768 - 63 487	Logical link identification for support of user information
63 488 - 64 511	Layer 2 management of Frame Relay service
64 512 - 65 534	Reserved
65 535 (note 2)	In channel layer 2 management, if required
17 bit DLCIs (note 4)	
0 (note 2)	In channel signalling, if required
1 - 2 047	Reserved
2 048 - 65 535	On non D-channel, available for support of user information
65 536 - 126 975	Logical link identification for support of user information
126 976 - 129 023	Layer 2 management of Frame Relay service
129 024 - 131 070	Reserved
131 071 (note 2)	In channel layer 2 management, if required
23 bit DLCIs (note 5)	
0 (note 2)	In channel signalling, if required
1 - 131 071	Reserved
131 072 - 4 194 303	On non D-channel, available for support of user information
NOTE 1: These DLCIs apply when a 2 octet address field is used or when a 3 octet address field is used with D/C = 1. NOTE 2: Only available within non D-channels. NOTE 3: These DLCIs apply for non D-channels when a 3 octet address field is used with D/C = 0. NOTE 4: These DLCIs apply for non D-channels when a 4 octet address field is used with D/C = 1. NOTE 5: These DLCIs apply for non D-channels when a 4 octet address field is used with D/C = 0.	

5.3.7 DLCI/DL-CORE control indicator (D/C)

The D/C bit indicates whether the remaining six usable bits of that octet are to be interpreted as the lower DLCI bits or as DL-CORE control bits. This bit is set to "0" to indicate that the octet contains DLCI information. This bit is set to "1" to indicate that the octet contains DL-CORE control information. This indicator is limited to use in the last octet of the three or four octet type "address field". The use of this indication for DL-CORE control protocol is reserved as there have not been any additional control functions defined which need to be carried in the "address field"; this indicator has been added to provide for possible future expansion of the protocol.

6 Placement of the DL-CORE sublayer protocol in the ISDN protocol architecture

This clause describes the placement of the DL-CORE protocol in the context of a layered architecture. The concepts of the Open Systems Interconnection (OSI) reference model (ITU-T Recommendation X.200 [9]), the OSI service conventions (ITU-T Recommendation X.210 [10]), and the ISDN protocol reference model (ITU-T Recommendation I.320 [6]) are used.

Communications between layers are accomplished by means of primitives. Primitives represent, in an abstract way, the logical exchange of information and control the data link and adjacent layers. They do not specify or constrain implementations.

Figures 3 and 4 depict the model which represents primitive interactions with messages for the support of the core service according to ITU-T Recommendation I.233 [5].

The User plane (U-plane) layer 2 is subdivided into:

a) a DL-CONTROL sublayer; and

b) a DL-CORE sublayer.

The DL-CORE sublayer provides core services to the user and a DL-CONTROL sublayer at the DL-CORE-SAP.

In the model shown in figures 3 and 4 covering Frame Relay service, the DL-CONTROL sublayer entities at the network side are not present.

Figure 3 depicts the signal flows at the calling access and called access interfaces. Figure 4 depicts the signal flows at the releasing access and released access interfaces.

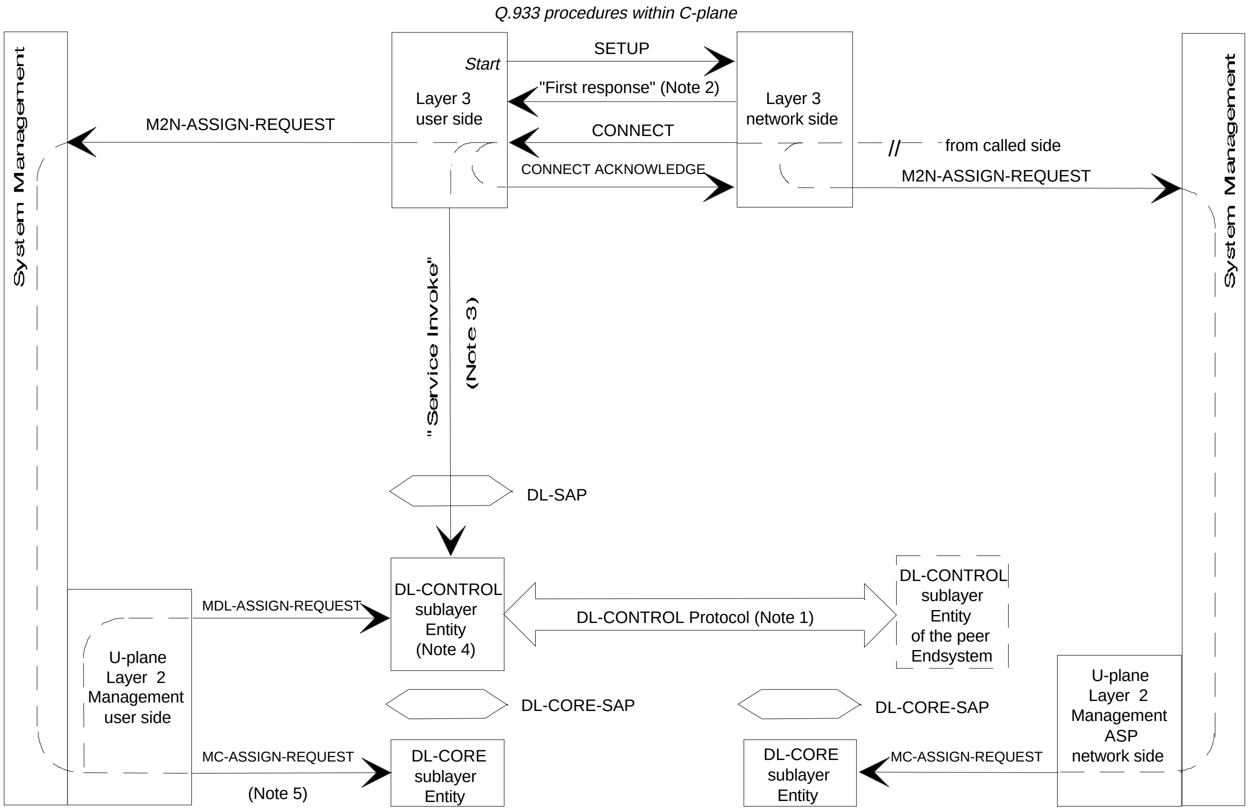
A summary of the primitives supported in this ETS is provided in table 3.

Table 3: Primitive types

Generic name	Type				Parameter		Message unit contents
	Request	Indication	Response	Confirma-tion	Priority indicator	Message unit	
layer 3 - layer 2 management							
M2N-ASSIGN	X	-	-	-	-	X	DL-CEI, DLCI (note 1)
M2N-REMOVE	X	-	-	-	-	X	DLCI
DL-CORE user - DL-CORE							
DL-CORE-DATA	X	X	-	-	-	X	see subclause 6.2.2
DL-CONTROL - layer 2 management							
MDL-ASSIGN	X	-	-	-	-	X	DL-CORE CEI, DL-CEI
MDL-REMOVE	X	-	-	-	-	X	DL-CORE CEI
DL-CORE - layer 2 management							
MC-ASSIGN	X	X	-	-	-	X	DLCI, DL-CORE CEI
MC-REMOVE	X	-	-	-	-	X	DLCI
layer 2 - layer 1							
PH-DATA	X	X	-	-	X (note 2)	X	Data link layer peer-to-peer message

NOTE 1: Optional parameters; if missing, default values are used or procedures of appendix III of CCITT Recommendation Q.922 [8] are used.

NOTE 2: A priority indicator for layer 1 is not present in CCITT Recommendation X.211 [11] and is used only for the basic interface D-channel. CCITT Recommendation X.211 [11] does not consider priority as a layer 1 quality of service parameter.



NOTE 1: The DL-CONTROL protocol may be a CCITT Recommendation Q.922 [8] protocol procedure, another ITU-T specified protocol, or any protocol between end systems which, as a DL-CORE service user, is compatible with the DL-CORE sublayer services.

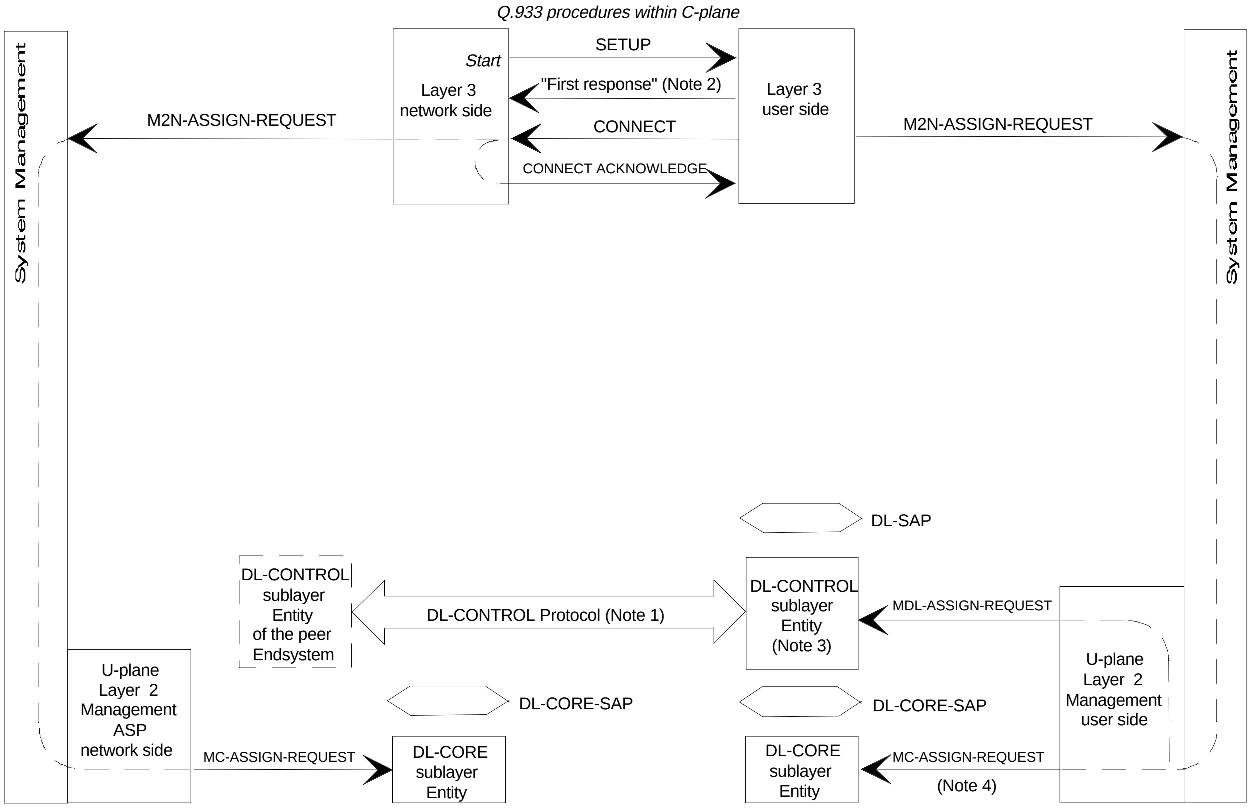
NOTE 2: The reserved DLCI is indicated in the first response to the SET-UP message, e.g. CALL PROCEEDING.

NOTE 3: The "service invoke" is not further defined in this ETS since it depends on the service provided by the DL-CONTROL sublayer.

NOTE 4: For Frame Relay, this DL-CONTROL sublayer entity established the U-plane layer 2 connection between the two end systems. Since there is no DL-CONTROL sublayer entity present at the network side (calling side), no collision is enforced between the U-plane layer 2 Protocol Data Units (PDUs), if any, establishing the U-plane link.

NOTE 5: This reflects the case when the MC-ASSIGN request is received prior to the DL-CORE-DATA request; otherwise, an MC-ASSIGN indication would be issued to acquire a DLCI.

Figure 3 (1 sheet of 2): Relationship of primitives with messages for core services connection establishment (outgoing call)



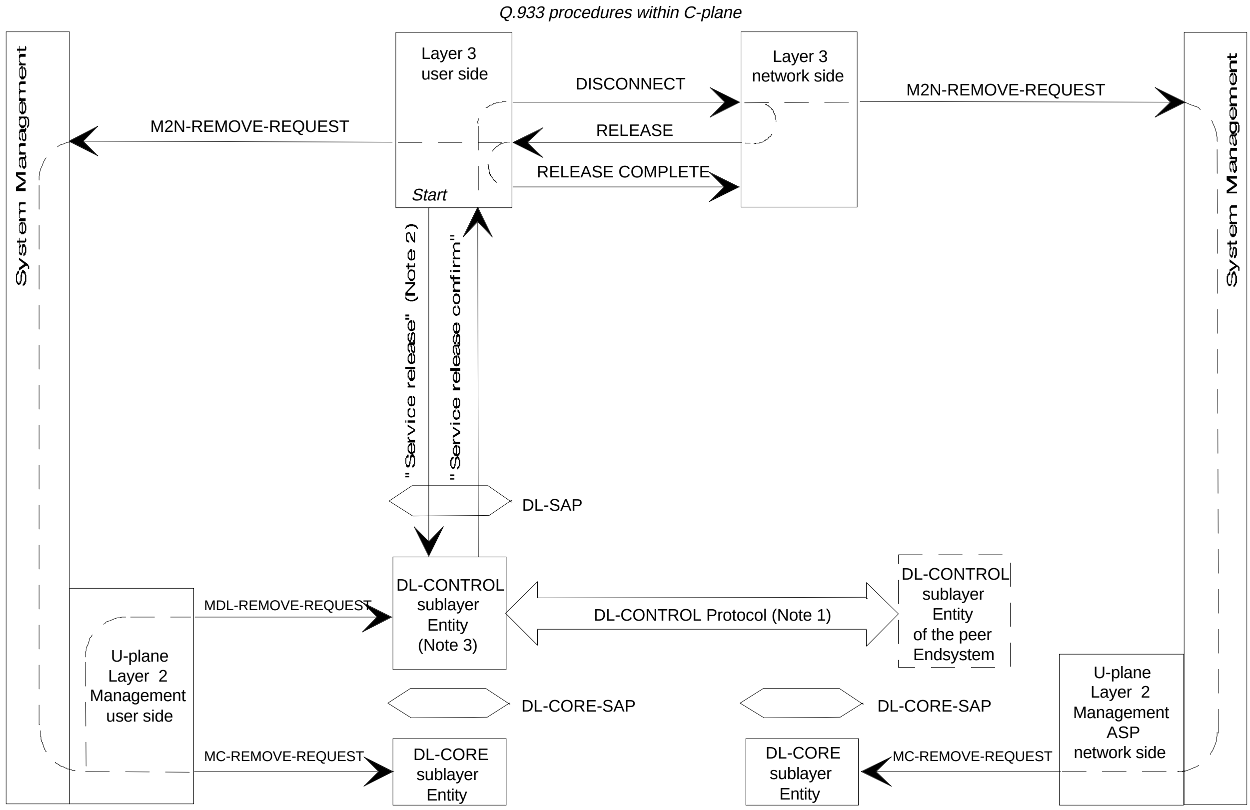
NOTE 1: The DL-CONTROL protocol may be a CCITT Recommendation Q.922 [8] protocol procedure, another ITU-T specified protocol, or any protocol between end systems which, as a DL-CORE service user, is compatible with the DL-CORE sublayer services.

NOTE 2: The reserved DLCI is indicated in the first response to the SET-UP message, e.g. CALL PROCEEDING.

NOTE 3: For Frame Relay, this DL-CONTROL sublayer entity established the U-plane layer 2 connection between the two end systems. Since there is no DL-CONTROL sublayer entity present at the network side (calling side), no collision is enforced between the U-plane layer 2 PDUs, if any, establishing the U-plane link.

NOTE 4: This reflects the case when the MC-ASSIGN request is received prior to the DL-CORE-DATA request; otherwise, an MC-ASSIGN indication would be issued to acquire a DLCI.

Figure 3 (2 sheet of 2): Relationship of primitives with messages for core services connection establishment (incoming call)

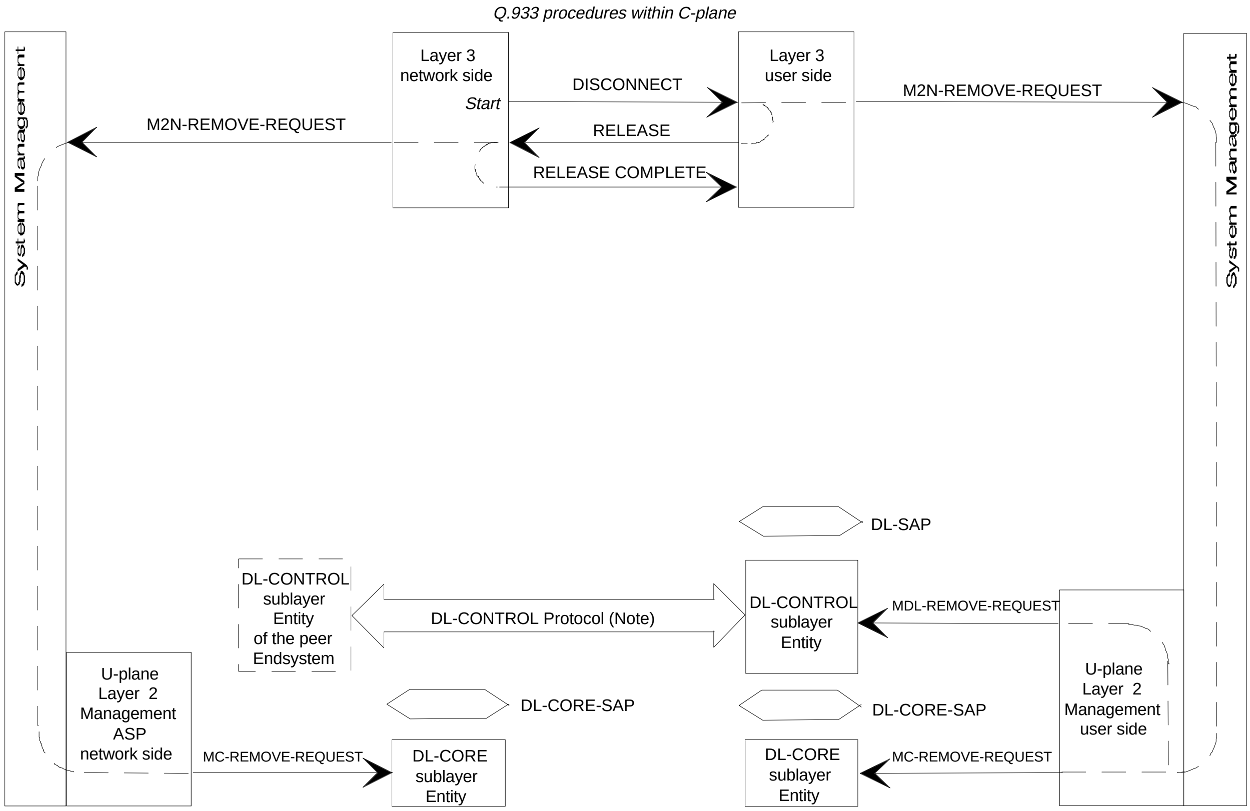


NOTE 1: The DL-CONTROL protocol may be a CCITT Recommendation Q.922 [8] protocol procedure, another ITU-T specified protocol, or any protocol between end systems which, as a DL-CORE service, is compatible with the DL-CORE sublayer services.

NOTE 2: The "service release" is not further defined in this ETS since it depends on the service provided by the DL-CONTROL sublayer. The "service release confirm" is requested to avoid premature release of the connection within the Control plane (C-plane).

NOTE 3: For Frame Relay, this DL-CONTROL sublayer entity established the U-plane layer 2 connection between the two end systems. Since there is no DL-CONTROL sublayer entity present at the network side (released side), no collision is enforced between the U-plane layer 2 PDUs, if any, releasing the U-plane link.

Figure 4 (1 sheet of 2): Relationship of primitives with messages for core services connection release (user initiated)



NOTE: The DL-CONTROL protocol may be a CCITT Recommendation Q.922 [8] protocol procedure, another ITU-T specified protocol, or any protocol between end systems which, as a DL-CORE service, is compatible with the DL-CORE sublayer services.

Figure 4 (2 sheet of 2): Relationship of primitives with messages for core services connection release (network initiated)

6.1 Support by the underlying physical layer service

The physical layer service is defined in the OSI physical layer service definition (CCITT Recommendation X.211 [11]). Only duplex (two-way simultaneous), point-to-point synchronous transmission is used. The optional PH connection activation and deactivation services of the physical layer are not presently used to support the DL-CORE protocol.

6.2 DL-CORE service

ITU-T Recommendation I.233 [5] provides a layer service description for the DL-CORE sublayer. The DL-CORE protocol is used to provide and support this layer service.

6.2.1 Primitives

The DL-CORE-DATA primitives are described in annex B of ITU-T Recommendation I.233 [5].

6.2.2 Parameters

The parameters associated with the DL-CORE-DATA primitives are defined in annex C/ITU-T Recommendation I.233 [5]. The mapping of these core service parameters to DL-CORE-PDU fields is given in table 4.

Table 4: Mapping of the core services parameters

Core service parameter (defined in ITU-T Recommendation I.233 [5])	DL-CORE-DATA primitive		DL-CORE-PDU field
	request	indication	
DL-CORE-User data	X	X	Information field
Discard eligibility	X		Discard eligibility
Congestion encountered backward		X	BECN
Congestion encountered forward		X	FECN
DL-CORE-Service-User protocol control information	X	X	C/R bit

6.2.3 Procedures

6.2.3.1 Primitives/Frame Relay frame mapping

When a DL-CORE entity receives a DL-CORE-DATA request from the DL-CORE service user, it sends a Frame Relay frame to its peer.

When a DL-CORE entity receives a valid Frame Relay frame, it signals a DL-CORE-DATA indication to the DL-CORE service user.

6.2.3.2 Parameters/fields mapping

The parameters of the DL-CORE-DATA request and DL-CORE-DATA indication primitives are directly mapped to the fields of the Frame Relay frame as shown in subclause 6.2.2.

6.3 Layer management

Table 3 shows the primitives exchanged between the DL-CORE sublayer management entity and the DL-CORE sublayer entity.

6.3.1 Primitives

6.3.1.1 MC-ASSIGN request

The MC-ASSIGN request primitive is used by the layer management entity to:

- signal to the DL-CORE sublayer entity that a DL-CORE connection has been established;
- convey the DLCI agreed to be used between DL-CORE entities in support of that core connection;
- convey the associated DL-CORE Connection Endpoint Identifier (CEI) to be used uniquely to identify the DL-CORE connection; and
- convey the PH CEI used to support the DL-CORE connection.

6.3.1.2 MC-REMOVE request

The MC-REMOVE request primitive is used by the layer management entity to signal to the DL-CORE sublayer entity that a DLCI has been released.

6.3.1.3 M2N-ASSIGN request

The M2N-ASSIGN request primitive is used by the C-plane layer 3 entity to request that the layer 2 management entity associate a DLCI with a DL-CEI, where both identifiers are specified in the message unit. Additional, optional parameters (e.g. physical channel) may be included in the message unit. The layer 2 management entity is prepared, thus, to receive an MC-ASSIGN indication primitive from the DL-CORE sublayer entity.

6.3.1.4 M2N-REMOVE request

The M2N-REMOVE request primitive is used by the C-plane layer 3 entity to request that the layer 2 management entity remove the association between the specified DLCI and its associated DL-CEI. The layer 2 management entity then uses the MC-REMOVE request primitive in accordance with subclause 6.3.1.2.

6.3.1.5 MDL-ASSIGN request

The MDL-ASSIGN request establishes a mapping in the DL-CONTROL sublayer entity between the DL-CORE CEI and the DL-CEI.

6.3.1.6 MDL-REMOVE request

The MDL-REMOVE request primitive is used by the layer 2 management entity to remove a mapping between a DL-CEI and a DL-CORE CEI.

6.3.2 Parameters

6.3.2.1 DLCI value

The DLCI value parameter conveys the DLCI agreed to be used between DL-CORE entities in support of a DL-CORE connection. Its syntax and usage by the protocol are defined in subclause 5.3.6.

6.3.2.2 DL-CORE Connection Endpoint Identifier (CEI)

The DL-CORE CEI uniquely identifies a DL-CORE connection. It is defined in ITU-T Recommendation I.233 [5].

6.3.2.3 DL CEI

The DL-CEI uniquely identifies a DL connection.

6.3.2.4 PH CEI

The PH CEI uniquely identifies a PH connection to be used in support of a DL-CORE connection.

6.3.3 Procedures

For permanent Frame Relay connections, information related to the operation of the DL-CORE protocol in support of DL-CORE connections is maintained by DL-CORE layer management. For demand Frame Relay connections, the layer 3 establishes and releases DL-CORE connections on behalf of the DL-CORE sublayer. Therefore, information related to the operation of the DL-CORE protocol is maintained by co-ordination of layer 3 management and DL-CORE sublayer management through the operation of the local systems environment.

6.3.3.1 DL-CORE connection establishment

When it is necessary to notify the DL-CORE sublayer entity (either because of establishment of a demand Frame Relay call, because of notification of re-establishment of a permanent Frame Relay connection or because of system initialization) that a DL-CORE connection is to be established, the DL-CORE layer management entity signals an MC-ASSIGN request primitive to the DL-CORE sublayer entity. In addition, the layer 2 management entity initiates an MDL-ASSIGN request to the DL-CONTROL sublayer entity.

The DL-CORE sublayer entity establishes the necessary mapping between the supporting PH connection, the DL-CORE-CEI and the DLCI. In addition, if it has not already done so, it begins to transmit flags on the PH connection.

The DL-CONTROL sublayer entity establishes the necessary mapping between the DL-CORE CEI and the DL-CEI.

6.3.3.2 DL-CORE connection release

When it is necessary to notify the DL-CORE sublayer entity (either because of release of a demand Frame Relay call or because of notification of failure of a permanent Frame Relay connection) that a DL-CORE connection is to be released, the DL-CORE layer management entity signals an MC-REMOVE request primitive to the DL-CORE sublayer entity, and an MDL-REMOVE request to the DL-CONTROL sublayer entity.

The DL-CORE sublayer entity removes any mapping between the supporting PH connection, the DL-CORE-CEI and the DLCI.

The DL-CONTROL sublayer entity removes any mapping between the DL-CORE CEI and the DL-CEI.

7 List of system parameters

The system parameters listed below are associated with each individual Frame Relay connection.

Maximum number of octets in a Frame Relay information field (N203)

The default for the maximum number of octets in a Frame Relay information field is 262 octets. The minimum Frame Relay information field size is one octet. The default maximum size was chosen for compatible operation with LAPD on the D-channel, which has a 2 octet control field and a 260 octets maximum information field. All other maximum values are negotiated (e.g. using Q.931 procedures) between users and networks and between networks. The support by networks of a negotiated maximum value of at least 1 600 octets is strongly recommended for applications such as LAN interconnection to minimize the need for segmentation and reassembling by the user equipment.

8 Congestion control procedures

Congestion in the user plane occurs when traffic arriving at a resource exceeds the network's capacity. It can also occur for other reasons (e.g., equipment failure). Network congestion affects the throughput rate, delay and frame loss experienced by the end user.

End users should reduce their offered load in the face of network congestion. Reduction of offered load by an end user may well result in an increase in the effective throughput available to the end user during congestion.

Congestion control may be achieved by:

a) congestion avoidance mechanisms; and/or
b) congestion recovery mechanisms.

Congestion avoidance (see note) mechanisms, as described in subclause 8.2, are used at the onset of congestion to minimize its negative effect on the network and the user.

NOTE: Congestion avoidance, as defined in CCITT Recommendation I.370 [7], is intended to minimize degradation in the quality of service. The specification of the degree of degradation is beyond the scope of this ETS.

Congestion recovery mechanisms, as described in subclause 8.1, are used to prevent network collapse in the face of severe congestion.

Congestion avoidance and congestion recovery are effective and complementary forms of congestion control in Frame Relay networks.

8.1 Implicit congestion detection

For implicit congestion detection schemes, the Frame Relay network does not send an indication to the user.

The intent of this scheme is to reduce the offered load to the network by the end user. Use of such reduction by users is optional. An example of one approach is given in clause I.1 of appendix I of CCITT Recommendation Q.922 [8].

8.2 Explicit notification

Explicit notification is a procedure used for congestion avoidance. Explicit notification is a part of the data transfer phase protocol. Users should react to explicit congestion notification (i.e. the reaction is a highly desirable option). Users that are not able to act on explicit congestion notification shall have the capability to receive and ignore explicit notification generated by the network.

Reaction by the end user to the receipt of explicit congestion notification is rate based.

8.2.1 Explicit congestion signals

Explicit congestion signals are sent in both forward (towards frame destination) and backward (towards frame source) directions. Forward explicit congestion notification is provided by using the FECN bit in the address field. Backward explicit congestion notification is provided by one of two methods. When timely reverse traffic is available, the BECN bit in an appropriate address field may be used. Otherwise, a single consolidated link layer management message may be generated by the network (see annex A). The Consolidated Link Layer Management (CLLM) message travels on the U-plane physical path. The generation and transport of CLLM by the network is optional.

All networks shall transport the FECN and BECN bits without resetting.

8.2.2 Rate reduction strategy

The specific rate reduction strategy to be used by end users is not identified. An example is given in clause I.2 of appendix I of CCITT Recommendation Q.922 [8].

Annex A (normative): Consolidated Link Layer Management (CLLM) message

The support of the procedure (i.e. generation and transport) using the CLLM message, defined in this annex, is optional for the network.

The consolidated link layer management message is based on ISO/IEC 8885 [12] definition of the use of eXchange IDentification (XID) frames for the transport of functional information.

Figures A.1 and A.2 illustrate the format of this frame. Each parameter is described using the sequence type-length-value. The following subclauses describe the functional fields for the CLLM congestion message. All fields are binary encoded unless otherwise specified.

Octet	Bit 8 7 6 5 4 3 2 1	Field name
1	1 1 1 1 1 0 R 0	Address Octet 1 (R indicates "response")
2	1 1 1 1 0 0 0 1	Address Octet 2
3	1 0 1 0 1 1 1 1	XID Control Field
4	1 0 0 0 0 0 1 0	Format Identifier (130)
5	0 0 0 0 1 1 1 1	Group Identifier = 15 (Private Parameters Negotiation)
6		Group Length Octet 1
7		Group Length Octet 2
8	0 0 0 0 0 0 0 0	Parameter Identifier = 0 (Parameter set identification)
9	0 0 0 0 0 1 0 0	Parameter Length (4)
10	0 1 1 0 1 0 0 1	Parameter value = 105 (IA5 coded I)
11	0 0 1 1 0 0 0 1	Parameter value = 49 (IA5 coded 1)
12	0 0 1 1 0 0 1 0	Parameter value = 50 (IA5 coded 2)
13	0 0 1 1 0 0 1 0	Parameter value = 50 (IA5 coded 2)
14	0 0 0 0 0 0 1 0	Parameter Identifier = 2 (cause id.)
15	0 0 0 0 0 0 0 1	Parameter length = 1
16		Cause value
17	0 0 0 0 0 0 1 1	Parameter value = 3 (DLCI identifier)
18		Parameter length
19		DLCI value octet 1
20		DLCI value octet 2
⋮	⋮	⋮
2n+17		DLCI value octet (nth DLCI)
2n+18		DLCI value octet (nth DLCI)
2n+19		FCS Octet 1
2n+20		FCS Octet 2

Figure A.1: CLLM message (B-channel) using 2 octet address field

Octet	Bit 8 7 6 5 4 3 2 1	Field name
1	1 1 1 1 1 0 R 0	Address Octet 1 (SAPI = 62) (R indicates "response")
2	1 1 1 1 1 1 1 1	Address Octet 2 (TEI = 127)
3	1 0 1 0 1 1 1 1	XID Control Field
4	1 0 0 0 0 0 1 0	Format Identifier (130)
5	0 0 0 0 1 1 1 1	Group Identifier = 15 (Private parameters negotiation)
6		Octets 6 up to 2n+18 as for B-channel in figure A.1
⋮	⋮	⋮
2n+18		Octets 6 up to 2n+18 as for B-channel in figure A.1
2n+19		FCS Octet 1
2n+20		FCS Octet 2

Figure A.2: CLLM message (D-channel) using 2 octet address field

A.1 Address octets

The default address size of two octets is used in the following specification.

Octets 1 and 2 represent the address field for a default two octet address. The first octet includes the 6 bits upper DLCI subfield. The second octet includes the 4 bits lower DLCI subfield.

The CLLM message is sent in an XlD-response frame. Except when delivered on a D-channel, it is sent in the management DLCI as shown in figure A.1. The congestion indication bits and the discard eligibility indicator are not used in this case and should be set to "0". When delivered on the D-channel, it is sent using a two octet address field with bits 8 to 4 of the first address field octet and bits 8 to 2 of the second address field octet set to "1" and bit 3 of the first octet set to "0" as shown in figure A.2. The congestion indication bits and the discard eligibility indicator do not exist in this case.

Octets 1 and 2 of the XID frame represent the address field and bit 2 of octet 1 is the Command/ Response bit (C/R). In a congestion control application, the receipt of a congestion message should not result in transmission of a subsequent frame, which would add to the traffic congestion. Therefore, the CLLM shall be sent in an XID response frame, i.e. the C/R bit shall be set to "1".

A.2 Control field

Octet 3 contains the control field code point for this type of message. This represents the control field for XID.

A.3 XID information field

A.3.1 Format identifier field

Octet 4 contains the Format identifier field. ISO/IEC 8885 [12] assigns the value of 130 decimal as a general purpose format identifier, and it is used by layer management for parameter negotiation as described in appendix III of CCITT Recommendation Q.922 [8].

A.3.2 Group field

A.3.2.1 Group identifier field

Octet 5 contains the Group identifier field. The Group identifier field is "15" decimal, which is assigned by ISO/IEC 8885 [12] to indicate private parameters.

NOTE: In the context of ISO/IEC 8885 [12], "private" is taken to mean a parameter beyond the scope of the HDLC specific parameters defined in ISO/IEC 8885 [12].

A.3.2.2 Group length field

Octets 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 for compatibility with the D-channel applications where the information field is a maximum of 260 octets.

A.3.2.3 Group value field

The Group value field consists of two or more parameter fields. The Parameter Set identification, Parameter 0, identifies the set of private parameters within the group value field for ISO/IEC 8885 [12]. The other parameters shall appear in the following order: Cause identifier and then DLCI identifier.

A.3.3 Parameter for Parameter set identification

The Parameter set identification parameter shall always be present; otherwise, the frame shall be rejected.

A.3.3.1 Parameter set identification field

Octet 8 contains the Parameter identifier field for the first parameter and is set to "0" for ISO/IEC 8885 [12]. Parameter 0 identifies the set of private parameters within this group.

A.3.3.2 Parameter set identification length field

Octet 9 contains the length of Parameter 0 and is set to binary "4" (0x04).

A.3.3.3 Parameter value field

Octets 10 to 13 identify that this usage of the XID frame private parameter group is for ITU-T Recommendation I.122 [4] private parameters. Octet 10 contains the IA5 value of "I" (0x49). Octet 11 contains the IA5 value of "1" (0x31). Octets 12 and 13 each contain the IA5 value of "2" (0x32).

A.3.4 Parameter field for Cause identifier

The Cause identifier shall always be present; otherwise, the frame shall be ignored.

A.3.4.1 Parameter identifier field

Octet 14 contains the Cause identification field. When the Cause identifier field is set to "2" (0x02), then the following octets of this parameter contain a length parameter set to "1" (0x01) and a Cause identifier.

A.3.4.2 Parameter length field

Octet 15 contains the length of the Cause identifier. This shall be set to binary "1" (0x01).

A.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. A summary of Cause values supported by this ETS is provided in table A.1.

Table A.1: Cause values

Bits **8 7 6 5 4 3 2 1**	**Cause**
0 0 0 0 0 0 1 0	Network congestion due to excessive traffic-short term
0 0 0 0 0 0 1 1	Network congestion due to excessive traffic-long term
0 0 0 0 0 1 1 0	Facility or equipment failure-short term
0 0 0 0 0 1 1 1	Facility or equipment failure-long term
0 0 0 0 1 0 1 0	Maintenance action-short term
0 0 0 0 1 0 1 1	Maintenance action-long term
0 0 0 1 0 0 0 0	unknown-short term
0 0 0 1 0 0 0 1	unknown-long term
All other values are reserved.	
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 is network specific.	

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

A.3.5 Parameter field for DLCI identifier

If the DLCI identifier is missing, then the frame shall be ignored.

A.3.5.1 Parameter identifier field

When the parameter identifier field is set to "3", then the following octets of this parameter contain the DLCI(s) of the Frame Relay connection(s) that are congested.

A.3.5.2 Parameter length field

Octet 18 contains the length of the 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.

A.3.5.3 Parameter value field

Octets 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. Bit 8 of the first octet is the most significant bit and bit 5 of the second octet is the least significant. Bits 2 to 1 in the first octet and bits 4 to 1 in the second octet are reserved.

A.4 Frame check sequence field

The last two octets of the frame contain the FCS field.

A.5 Action of the congested node

When a node becomes congested, it may send notification of the congested state by setting forward and backward congestion bits to "1" in the address field and/or using a Consolidated link layer management message on the management data link. The purposes of the explicit congestion notification are:

1) to inform the edge node at the network ingress of the congestion so that the edge node can take appropriate action to reduce network congestion; and/or

2) to notify the source that negotiated throughput has been exceeded.

The consolidated link layer management message contains a list of DLCIs that correspond to the congested Frame Relay connections. These DLCIs will correspond both to sources that are currently active and those that are not. The purpose of the latter action is to prevent those sources from becoming active and hence increasing congestion. It may be necessary to send more than one consolidated link layer management message, if all DLCIs cannot fit within a single frame.

History

Document history			
August 1995	Public Enquiry	PE 90:	1995-08-21 to 1995-12-15
May 1996	Vote	V 102:	1996-05-06 to 1996-08-09
August 1996	First Edition		

ISBN 2-7437-0354-7 - Edition complète
ISBN 2-7437-0848-4 - Partie 3
Dépôt légal : Août 1996