



INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

X.76

(02/2003)

SERIES X: DATA NETWORKS AND OPEN SYSTEM
COMMUNICATIONS

Public data networks – Transmission, signalling and
switching

**Network-to-network interface between public
networks providing PVC and/or SVC frame relay
data transmission service**

ITU-T Recommendation X.76

ITU-T X-SERIES RECOMMENDATIONS
DATA NETWORKS AND OPEN SYSTEM COMMUNICATIONS

PUBLIC DATA NETWORKS	
Services and facilities	X.1–X.19
Interfaces	X.20–X.49
Transmission, signalling and switching	X.50–X.89
Network aspects	X.90–X.149
Maintenance	X.150–X.179
Administrative arrangements	X.180–X.199
OPEN SYSTEMS INTERCONNECTION	
Model and notation	X.200–X.209
Service definitions	X.210–X.219
Connection-mode protocol specifications	X.220–X.229
Connectionless-mode protocol specifications	X.230–X.239
PICS proformas	X.240–X.259
Protocol Identification	X.260–X.269
Security Protocols	X.270–X.279
Layer Managed Objects	X.280–X.289
Conformance testing	X.290–X.299
INTERWORKING BETWEEN NETWORKS	
General	X.300–X.349
Satellite data transmission systems	X.350–X.369
IP-based networks	X.370–X.399
MESSAGE HANDLING SYSTEMS	X.400–X.499
DIRECTORY	X.500–X.599
OSI NETWORKING AND SYSTEM ASPECTS	
Networking	X.600–X.629
Efficiency	X.630–X.639
Quality of service	X.640–X.649
Naming, Addressing and Registration	X.650–X.679
Abstract Syntax Notation One (ASN.1)	X.680–X.699
OSI MANAGEMENT	
Systems Management framework and architecture	X.700–X.709
Management Communication Service and Protocol	X.710–X.719
Structure of Management Information	X.720–X.729
Management functions and ODMA functions	X.730–X.799
SECURITY	X.800–X.849
OSI APPLICATIONS	
Commitment, Concurrency and Recovery	X.850–X.859
Transaction processing	X.860–X.879
Remote operations	X.880–X.899
OPEN DISTRIBUTED PROCESSING	X.900–X.999

For further details, please refer to the list of ITU-T Recommendations.

Network-to-network interface between public networks providing PVC and/or SVC frame relay data transmission service

Summary

This Recommendation describes the frame relay network-to-network interface intended for the interconnection of public networks providing PVC and/or SVC frame relay data transmission service. The signalling at the NNI for frame relay SVC is applicable to public data networks supporting ITU-T Rec. X.36 at the DTE/DCE interface. Details of physical layer, data transfer and signalling procedures for SVC and PVC at the network-to-network interface are defined. PVC signalling procedures have been enhanced with a new segmentation capability procedure to increase the number of PVC status reports.

Recognizing that frame relay bearer services and signalling are not supported by ISDN local exchanges, Case B has been removed from ITU-T Rec. Q.933 (2003). Consequently this version of ITU-T Rec. X.76 no longer supports the NNI signalling capabilities specific to ITU-T Rec. Q.933 (1995) Case B.

This revision replaces ITU-T Rec. X.76 (2000). This revised ITU-T Rec. X.76 (2003) is in alignment with the latest release of ITU-T Recs Q.933 (2003) and X.36 (2003).

Source

ITU-T Recommendation X.76 was approved by ITU-T Study Group 17 (2001-2004) under the ITU-T Recommendation A.8 procedure on 13 February 2003.

FOREWORD

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CONTENTS

Page

1	Scope	1
2	References.....	1
3	Terms and definitions	2
4	Abbreviations.....	3
5	Conventions	3
6	Physical layer.....	3
7	Reference configuration.....	4
8	Service parameters and service quality.....	4
8.1	Scope	4
8.2	Service parameters.....	4
8.3	Service quality	5
9	Data link transfer control	6
9.1	General	6
9.2	Frame format	6
9.3	Addressing	7
9.4	Transmission considerations	9
10	Frame relay SVC signalling	11
10.1	General	11
10.2	Signalling channel	12
10.3	State definitions	14
10.4	Message definitions	14
10.5	General message format and information element coding	20
10.6	Call establishment	44
11	Additional procedures for PVCs using unnumbered information frames	60
11.1	Overview	60
11.2	Message definition.....	61
11.3	Message specific information elements.....	62
11.4	Description of procedures.....	64
11.5	Bidirectional aspects of operation	69
11.6	Asynchronous PVC STATUS message.....	70
11.7	System parameters.....	71
12	Congestion control.....	72
Annex A	– Signalling for switched PVC (SPVC)	72
A.1	Messages needed for SPVC establishment.....	74
A.2	Called party SPVC information element.....	74
A.3	Calling party SPVC information element.....	75
A.4	SPVC Procedures	76

	Page
Annex B – Usage of cause and location	81
B.1 Location field generation.....	81
B.2 Cause values	82
B.3 Coding of the diagnostic field	91
Annex C – Enhancements to PVC management procedures	93
C.1 Introduction	93
C.2 List of changes to clause 11.....	93
Appendix I – Network congestion scenarios	94
Appendix II – International network identification according to ITU-T Rec. X.125 for networks providing frame relay services and numbered under the E.164 numbering plan	95
II.1 Introduction	95
II.2 Assignment and notification process.....	95
Appendix III – Call state diagrams at one STE side of the NNI.....	95
III.1 Symbol definition of the call state diagrams	95
Appendix IV – Action taken by the STE on receipt of a message in a given call state at one side of NNI.....	98

Network-to-network interface between public networks providing PVC and/or SVC frame relay data transmission service

1 Scope

Recognizing that public networks are offering the frame relay data transmission service, there is a need for a standard network-to-network interface to enable interworking. This Recommendation provides the structural details required to implement such an interface. Procedures for PVC and SVC operation are provided.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provision of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; 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 the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

- ITU-T Recommendation E.164/I.331 (1997), *The international public telecommunication numbering plan*.
- ITU-T Recommendation E.166/X.122 (1998), *Numbering plan interworking for the E.164 and X.121 numbering plans*.
- ITU-T Recommendation G.703 (2001), *Physical/electrical characteristics of hierarchical digital interfaces*.
- ITU-T Recommendation G.704 (1998), *Synchronous frame structures used at 1544, 6312, 2048, 8448 and 44 736 kbit/s hierarchical levels*.
- ITU-T Recommendation I.122 (1993), *Framework for frame mode bearer services*.
- ITU-T Recommendation I.233.1 (1991), *Frame mode bearer services: ISDN frame relaying bearer service*.
- ITU-T Recommendation I.370 (1991), *Congestion management for the ISDN frame relaying bearer service*.
- ITU-T Recommendation I.372 (1993), *Frame relaying bearer service network-to-network interface requirements*.
- ITU-T Recommendation I.430 (1995), *Basic user-network interface – Layer 1 specification*.
- ITU-T Recommendation I.431 (1993), *Primary rate user-network interface – Layer 1 specification*.
- ITU-T Recommendation Q.850 (1998), *Usage of cause and location in the Digital Subscriber Signalling System No. 1 and Signalling System No. 7 ISDN User Part*.
- ITU-T Recommendation Q.920 (1993), *ISDN user-network interface data link layer – General aspects*.
- ITU-T Recommendation Q.921 (1997), *ISDN user-network interface – Data link layer specification*.

- ITU-T Recommendation Q.922 (1992), *ISDN data link layer specification for frame mode bearer services*.
- ITU-T Recommendation Q.931 (1998), *ISDN user-network interface layer 3 specification for basic call control*.
- ITU-T Recommendation Q.933 (2003), *ISDN Digital subscriber Signalling System No. 1 (DSS1) – Signalling specifications for frame mode switched and permanent virtual connection control and status monitoring*.
- ITU-T Recommendations Q.951.x-series, *Stage 3 service description for number identification supplementary services using DSS1*.
- ITU-T Recommendation T.50 (1992), *International Reference Alphabet (IRA) (Formerly International Alphabet No. 5 or IA5) – Information technology – 7-bit coded character set for information interchange*.
- ITU-T Recommendation X.36 (2003), *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.37 (1995), *Encapsulation in X.25 packets of various protocols including frame relay*.
- ITU-T Recommendation X.92 (1988), *Hypothetical reference connections for public synchronous data networks*.
- ITU-T Recommendation X.121 (2000), *International numbering plan for public data networks*.
- ITU-T Recommendation X.124 (1999), *Arrangements for the interworking of the E.164 and X.121 numbering plans for frame relay and ATM networks*.
- ITU-T Recommendation X.125 (1998), *Procedure for the notification of the assignment of international network identification codes for public frame relay data networks and ATM networks numbered under the E.164 numbering plan*.
- ITU-T Recommendation X.212 (1995) | ISO/IEC 8886:1996, *Information technology – Open Systems Interconnection – Data link service definition*.
- ITU-T Recommendation X.213 (2001) | ISO/IEC 8348:2002, *Information technology – Open Systems Interconnection – Network service definition*.

3 Terms and definitions

This Recommendation defines the following terms:

- a) Committed Information Rate (CIR) as in 8.2.4;
- b) Committed Burst Size (Bc) as in 8.2.2;
- c) Excess Burst Size (Be) as in 8.2.3;
- d) Committed Rate Measurement Interval (Tc) as in 8.2.5;
- e) Access Rate (AR) as in 8.2.1;
- f) Maximum octet length of frame relay information field (N203) as in 8.2.6;
- g) N391 as in 11.4 and Table 32;
- h) N392 as in 11.4 and Table 32;

- i) N393 as in 11.4 and Table 32;
- j) T391 as in 11.4 and Table 33;
- k) T392 as in 11.4 and Table 33.

NOTE – The names of the timers and counters in items g) to k) are aligned with Annex A/Q.933 terminology.

4 Abbreviations

This Recommendation uses the following abbreviations:

AR	Access Rate
Bc	Committed Burst Size
Be	Excess Burst Size
BECN	Backward Explicit Congestion Notification
C/R	Command/Response
CIR	Committed Information Rate
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
FECN	Forward Explicit Congestion Notification
FRDTS	Frame Relay Data Transmission Service
LAPF	Link Access Procedure for Frame mode bearer service
PDN	Public Data Network
PVC	Permanent Virtual Circuit
SPVC	Switched Permanent Virtual Circuit
STE	Signalling Terminal
SVC	Switched Virtual Circuit
Tc	Committed Rate Measurement Interval
VC	Virtual Circuit

5 Conventions

No special conventions are employed within this Recommendation.

6 Physical layer

The characteristics of the network-to-network interface, defined as the physical layer element, shall be in accordance with ITU-T Rec. G.703. When used, the frame structure conforms to ITU-T Rec. G.704. In the case of 2 Mbit/s, time slot 0 is used to perform fault detection (see ITU-T Rec. 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.

Other recognized rates may also be used, in which case the signalling terminal/physical circuit interface shall be in accordance with the appropriate V or X-series Recommendations, for example:

- V.24;
- V.35;
- V.36;
- X.21.

Each physical circuit must be able to support duplex operation.

In the case of international interworking between public data networks providing FRDTS, the link is assumed to be data link A1 and/or data link G1 in terms of the hypothetical reference connections defined in ITU-T Rec. X.92.

NOTE – The use of SDH Interface is for further study.

7 Reference configuration

Figure 1 illustrates the possible locations of the network-to-network interface. The interfaces connect public data networks providing FRDTS.

8 Service parameters and service quality

8.1 Scope

This clause describes the service parameters needed to define the necessary service requirements and control management for handling congestion during the data transmission phase in a public data network providing frame relay data transmission services.

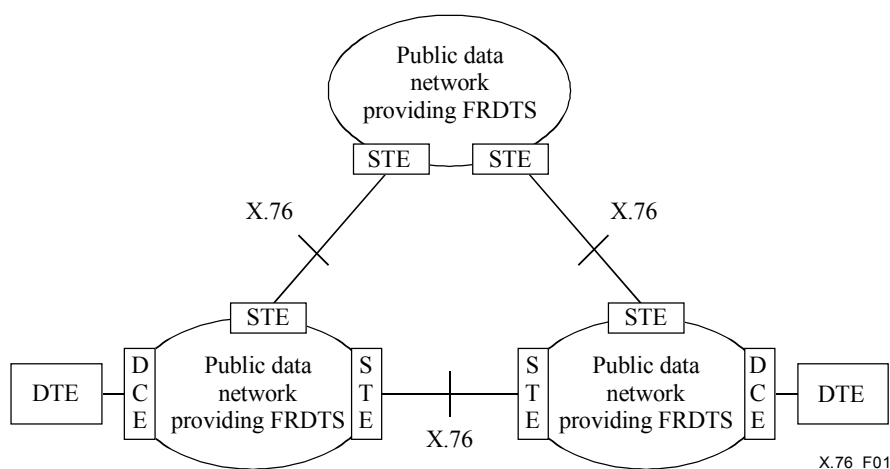


Figure 1/X.76 – Locations of network-to-network interface

8.2 Service parameters

8.2.1 access rate (AR): The access rate is the maximum data rate at which data can be injected into or extracted from the network. It is determined by the speed of the access channel. The access rate is bilaterally agreed between the two connecting networks for a period of time. The access rate parameter is provisioned once per STE.

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 values used for this parameter are bilaterally agreed between the two connecting networks for a period of time. The values used at each STE should be chosen to provide the desired

end-to-end service. This service parameter is provisioned once for each VC at an STE. The value of this parameter can be different for each direction of transmission. That is, each STE on a network-to-network interface can support a different value of this parameter for a particular VC.

8.2.3 excess burst size (Be): The excess burst size is the amount of uncommitted data that the network shall endeavour to deliver in addition to the Committed Burst Size (Bc) for a particular virtual circuit during interval Tc (see 8.2.5 (Tc)). The values used for this parameter are bilaterally agreed between the two connecting networks for a period of time. The values used at each STE should be chosen to provide the desired end-to-end service. This service parameter is provisioned once for each VC at an STE. The value of this parameter can be different for each direction of transmission. That is, each STE on a network-to-network interface can support a different value of this parameter for a particular VC.

8.2.4 committed information rate (CIR): The information transfer rate which the network is committed to transfer for a particular virtual circuit under normal conditions. The rate is the average committed burst size over the time interval of Tc. The values used for this parameter are bilaterally agreed between the two connecting networks for a period of time. The values used at each STE should be chosen to provide the desired end-to-end service. This service parameter is provisioned once for each VC at an STE. The value of this parameter can be different for each direction of transmission. That is, each STE on a network-to-network interface can support a different value of this parameter for a particular VC.

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. It is calculated according to the following formula:

- 1) if $CIR > 0$, $Tc = Bc/CIR$;
- 2) if $CIR = 0$, Tc is set to a network dependent value. The values used for this parameter are bilaterally agreed between the two connecting networks for a period of time. The values used at each STE should be chosen to provide the desired end-to-end service. This service parameter is provisioned once for each VC at an STE.

The value of this parameter can be different for each direction of transmission. That is, each STE on a network-to-network interface can support a different value of this parameter for a particular VC.

8.2.6 maximum octet length of frame relay information field (N203): The maximum octet length of the frame relay information field is the maximum supportable number of user octets. Octets are counted from the octet immediately following the address field to the octet immediately preceding the FCS field inclusive (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. This parameter is determined at subscription time. All networks shall support at least a value of 1600 octets. In addition, maximum information field sizes less than or greater than 1600 octets may be agreed to between networks during VC provisioning. The value of N203 is bilaterally agreed between the two connecting networks for a period of time. This service parameter is provisioned once for each PVC at an STE. The value of this parameter can be different for each direction of transmission. That is, each STE on a network-to-network interface can support a different value of this parameter for a particular VC.

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 level excess traffic characterized by the parameter Be may also be delivered within a certain probability. (More details on this aspect can be found in ITU-T Rec. X.144.)

9 Data link transfer control

9.1 General

This clause describes the frame structure, elements of procedure, format of fields and procedures for the operation of the frame relay data transmission service at layer 2 on the network-to-network interface. The core attributes of LAPF (as described in Annex A/Q.922) used to support the frame relay data transmission service are:

- 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;
- congestion control functions.

9.2 Frame format

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

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. The closing flag may also serve 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 four octets by bilateral agreement. The format of the address field is defined in 9.3.2.

9.2.3 Information field

The information field of a frame follows the address field (see 9.3.2) and precedes the frame check sequence field (see 9.2.4). 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.

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

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

Figure 2/X.76 – Frame format with 2-octet address

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 field format and procedures used by FRDTS services for data link transfer. Data link connection is governed by the address field elements which support optional procedures such as congestion management which are found in clause 12. The field information is set in accordance with the address field defined by the FRDTS frame format (see Figure 3).

9.3.2 Address field format

The address field format shown in Figure 3 contains the address field extension bits, a command/response indication, 3 bits reserved for explicit congestion notification and discard eligibility indication and a Data Link Connection Identifier (DLCI). The support of 2-octet address field is mandatory. A bit is also included to indicate whether the final octet of a 4-octet address field is the low order part of the DLCI or control information.

9.3.3 Address field elements

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 across network-to-network interfaces.

9.3.3.3 Forward Explicit Congestion Notification bit (FECN bit)

This bit may be set by a congested network to notify the receiving STE 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 STE that the frames it receives have encountered congested resources. This bit may be used by the destination DTE to initiate transmitter rate adjustment. While setting this bit by an STE is optional, no STE shall ever clear (set to 0) this bit. An STE that does not provide FECN shall pass this bit unchanged. Explanations of the use of this bit can be found in clause 12/X.36. See Figure 3.

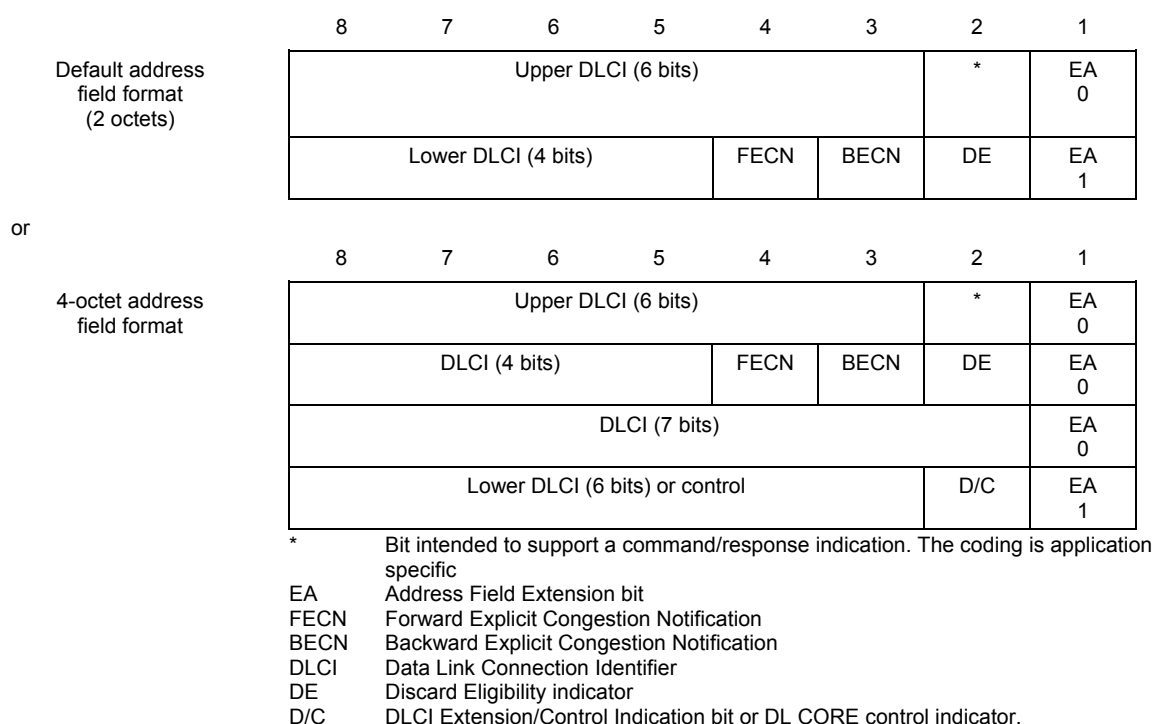


Figure 3/X.76 – Address field format

9.3.3.4 Backward Explicit Congestion Notification bit (BECN bit)

This bit may be set by a congested network to notify the receiving STE 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 STE 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 an STE is optional, no STE shall ever clear (set to 0) this bit. An STE that does not provide BECN shall pass this bit unchanged. Explanation of the use of this bit can be found in clause 12/X.36.

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 is optional. No network shall ever clear (reset 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 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 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 network-to-network interface. Its value is determined either at subscription time for permanent virtual circuits or at call set-up time for switched virtual circuits. The maximum number of virtual circuits supported for a network-to-network interface is dependent on a bilateral agreement between the two networks involved.

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.

The various values for DLCI are specified in Table 1.

Table 1a/X.76 – DLCI value range when 2-octet address field is used

DLCI range (10 bits)	Function
0	Signalling
1-15	Reserved
16-991	Virtual circuit identification
992-1007	Layer 2 management
1008-1022	Reserved
1023	Reserved for in channel layer 2 management, if required

Table 1b/X.76 – DLCI value range when 4-octet address field is used with D/C bit = 0

DLCI range (23 bits)	Function
0	Signalling
1-15	Reserved
16-991	Virtual circuit identification
992-1007	Layer 2 management
1008-1022	Reserved
1023-8388607	Reserved for in channel layer 2 management, if required
1024-8388607	Virtual circuit identification

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 4-octet format is used. This bit indicates whether the remaining six usable bits of the octet are to be interpreted as the lower DLCI bits or as control bits. The bit is set to 0 to indicate that the octet contains DLCI information. When the bit is set to 1, bits 3 to 8 of the last octet are no longer interpreted as DLCI bits and their use is for further study.

9.4 Transmission considerations

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.

8	7	6	5	4	3	2	1	Octet
								1
								2
								3
								.
								.
								.
								.
								n

Figure 4/X.76 – 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	Octet
Upper DLCI (6 bits)							EA	
2 ⁹	2 ⁸	2 ⁷	2 ⁶	2 ⁵	2 ⁴	C/R	0	1
Lower DLCI (4 bits)							EA	
2 ³	2 ²	2 ¹	2 ⁰	FECN	BECN	DE	1	2

Figure 5/X.76 – 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	Octet
2 ⁸	2 ⁹	2 ¹⁰	2 ¹¹	2 ¹²	2 ¹³	2 ¹⁴	2 ¹⁵	1
2 ⁰	2 ¹	2 ²	2 ³	2 ⁴	2 ⁵	2 ⁶	2 ⁷	2

Figure 6/X.76 – Order of values of the FCS bits

9.4.3 Transparency

Each transmitting data link 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. The receiving data link 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.

9.4.4 Interframe fill

For interframe 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 three 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 seven 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).

NOTE – Item b) above means that frames with an information field length equal to 0 are invalid frames. In case there is no traffic in a given transmission direction, the STE may use such invalid frames to send information about congestion in the opposite direction by means of the BECN bit set to 1 or 0. This use of invalid frames with an information field length equal to 0 is determined by bilateral agreement between the two networks involved. Further, these frames are used locally between the two STEs involved and will not be transferred to the DTE/DCE interfaces.

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 STE.

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 an STE is interpreted as an abort and the STE ignores the frame currently being received.

10 Frame relay SVC signalling

10.1 General

This clause defines the signalling to support frame relay Switched Virtual Circuits (SVC) at the Network-to-Network Interface (NNI), and is independent of the existing PVC signalling procedures defined in this Recommendation. It defines also the following additional facilities:

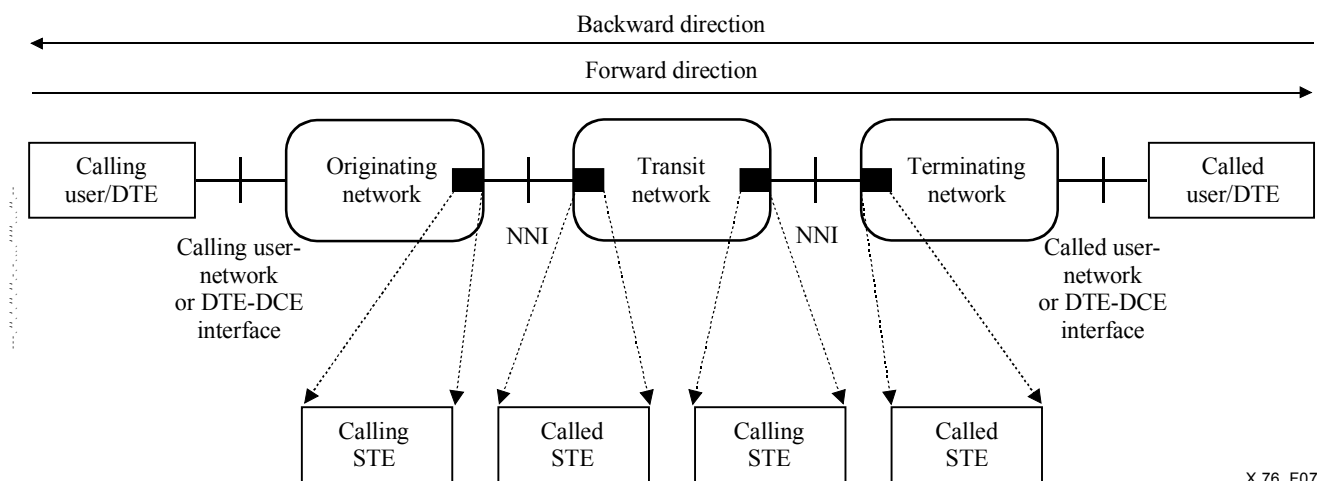
- transit network identification;
- call identification;
- closed user group interlock code;
- reverse charging indication;
- clearing network identification;
- transit network selection;
- frame transfer priority;
- frame discard priority;
- frame relay service class.

The signalling at the NNI for frame relay SVC is applicable to public data networks supporting ITU-T Rec. X.36 at the DTE/DCE interface.

NOTE – As ITU-T Rec. Q.933 (2003) no longer supports Case B Frame Mode Bearer Service provided by an ISDN local exchange, the specific states, messages, information elements, procedures and timers required to support ITU-T Rec. Q.933 have been deleted in this revision of ITU-T Rec. X.76.

The following terminology is used within this Recommendation:

- The calling user/DTE is connected to a public network at the calling UNI or DTE-DCE interface.
- The called user/DTE is connected to a public network at the called UNI or DTE-DCE interface.
- At the NNI, an originating network is the network to which the calling DTE/user is attached.
- A terminating network is a network to which the called DTE/user is attached.
- A transit network is an intermediate network connected to at least two other networks.
- A calling STE is an STE initiating a frame relay SVC or call establishment and a called STE is an STE receiving a request to establish a frame relay call.
- The forward direction is the direction from the calling to the called user/DTE. The backward direction is the direction from the called to the calling user/DTE. This convention is shown in Figure 7.



X.76_F07

Figure 7/X.76 – Convention used for SVC signalling

10.2 Signalling channel

ITU-T Rec. Q.922 defines the link layer protocol known as LAPF to provide a reliable data link connection for the exchange of SVC signalling messages defined in this clause across a frame relay NNI. See Figure 8.

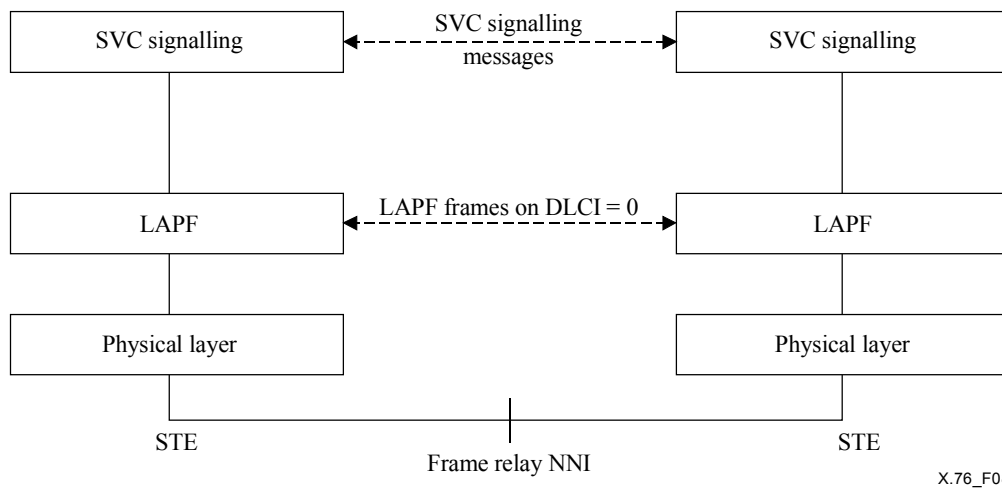


Figure 8/X76 – STE/STE protocol layers for signalling

The following frame types identified in ITU-T Rec. Q.922 and defined in ITU-T Rec. Q.921 must be supported:

- Set Asynchronous Balanced Mode Extended (SABME) command;
- Disconnect (DISC) command;
- Receive Ready (RR) command and response;
- REJect (REJ) command/response;
- Receive Not Ready (RNR) command/response;
- I frames;
- Unnumbered Acknowledgment (UA) response;
- Disconnected Mode (DM) response;
- Frame Reject (FRMR) response.

XID frames are not used and Unnumbered Information (UI) frames are used for PVC signalling. SVC signalling does not affect PVC signalling since, for SVC signalling, I frames are used whereas, for PVC signalling, UI frames are used.

In order to exchange SVC signalling messages across the NNI, a LAPF link has to be established using DLCI = 0. After establishment of a LAPF link, the data link connection identified with DLCI = 0 is automatically ready for the exchange of the signalling messages across the NNI. This LAPF link is known as the signalling channel.

On the signalling channel, FECN, BECN and DE bits are not used. They must be set to 0 upon transmission and must not be interpreted upon reception.

The values of the link layer parameters of the link layer protocol on the signalling channel are as follows:

- 1) Timer T200: The default value for the retransmission timer T200, at the end of which transmission of a frame may be initiated according to the procedures of ITU-T Rec. Q.922 is 1 second;
- 2) Timer T203: The idle timer T203 represents the maximum time allowed without frames being exchanged and has a value 30 seconds;
- 3) Counter N200: The retransmission counter (N200) identifies the maximum number of retransmissions of a frame and has a value of 3;

- 4) **Maximum number of outstanding I frames (k):** The maximum number (k) of sequentially numbered I frames that may be outstanding (that is, unacknowledged) at any given time is a system parameter which shall not exceed 127. This parameter is also called "maximum window size". For a 16 kbit/s link, the default value shall be 3. For a 64 kbit/s link, the default value shall be 7. For a 384 kbit/s link, the default value shall be 32. For a 1.536 Mbit/s or 1.920 Mbit/s link, the default value shall be 40;
- 5) **Maximum number of octets in an information field (N201):** The default value of N201 for the maximum number of octets in an information field is 1600 octets. All other maximum values are negotiated between networks.

10.3 State definitions

10.3.1 Frame relay call states at the NNI

The following states are the states that may exist at either side of a frame relay NNI. These states are derived from X.36 states used at the network side of a UNI and use the equivalent state numbers.

- **Null state (NN0):** No switched virtual circuit exists.
- **Call initiated (NN1):** This state exists for a called STE after it has received a call establishment request from the calling STE but has not responded yet.
- **Call proceeding sent (NN3):** This state exists for a called STE when it has acknowledged the receipt of the information necessary to establish a call.
- **Call present (NN6):** This state exists for a calling STE after it has sent a call establishment request to the called STE but has not received a response.
- **Call proceeding received (NN9):** This state exists for a calling STE when it has received an acknowledgment that the called STE received the call establishment request.
- **Active (NN10):** This state exists when the frame relay SVC has been established and data transfer phase may begin.
- **Release request (NN11):** This state exists for an STE when it has sent a request to release the SVC.
- **Release indication (NN12):** This state exists for an STE when it has received a request to release the SVC and is waiting for a response.

10.3.2 States associated with restart

The following states are associated with restart:

- **Restart null (Rest0):** No restart request exists.
- **Restart request (Rest1):** This state exists for one STE after it has sent a restart request to the other STE and is waiting for an acknowledgment.
- **Restart (Rest2):** This state exists for one STE when it has received a request for a restart and has not returned an acknowledgment indicating the outcome of the restart.

10.4 Message definitions

The following messages are used at the frame Relay NNI:

- Call proceeding.
- Connect.
- Release.
- Release complete.
- Restart.
- Restart acknowledge.

- Setup.
- Status.
- Status enquiry.

Each message is described in this clause as follows:

- A brief definition of the purpose of the message.
- The message structure and content.
- The "significance" of the message:
 - local significance means that the message is applicable only at the NNI;
 - global significance means that the message is applicable to the two UNIs and the NNIs involved in the call.
- The direction in which the message may be sent: "Both" means the message can be sent by either side of the NNI. "Forward" means the message is sent only by the calling STE to the called STE and "backward" refers to the opposite direction.
- A table listing the information elements in the order of their appearance in the message – For each information element, the table indicates:
 - The clause describing the information element.
 - Whether the information element inclusion in the message is mandatory (M), or optional (O), with a reference to notes explaining the circumstances under which the information element shall be included.
 - The length of the information element (or permissible range of length) in octets – the character * denotes an undefined length which may be network or service dependent.
 - Further explanatory notes as necessary.

10.4.1 Alerting

The Alerting message is no longer supported in this Recommendation (see Note in 10.1).

Table 2/X.76 – ALERTING message content

(No longer supported)

10.4.2 Call proceeding

This message is sent by the called STE to the calling STE to indicate that the requested call establishment has been initiated. This message acknowledges the receipt of the SETUP message. See Table 3.

Table 3/X.76 – CALL PROCEEDING message content

Message type: CALL PROCEEDING		Direction: Backward	
Significance: Local			
Information element	Reference	Type	Length
Protocol discriminator	10.5.1	M	1
Call reference	10.5.2	M	3
Message type	10.5.3	M	1
Data link connection identifier	10.5.16	M	4-6

10.4.3 Connect

This message is sent by the called STE to the calling STE to indicate that the called user/DTE has accepted the call. See Table 4.

Table 4/X.76 – CONNECT message content

Message type: CONNECT		Direction: Backward	
Significance: Global			
Information element	Reference	Type	Length
Protocol discriminator	10.5.1	M	1
Call reference	10.5.2	M	3
Message type	10.5.3	M	1
Called party SPVC	A.2	O (Note 2)	5-7
Link layer core parameters	10.5.19	M (Note 3)	2-31
Connected number	10.5.14	O (Note 4)	2-19
Connected subaddress	10.5.15	O (Note 2)	2-23
Transit network identification	10.5.26	O (Note 5)	5-11
Low layer compatibility	10.5.21	O (Note 2)	2-16
Generic application transport	10.5.17 <i>bis</i>	O (Note 6)	2-257
User-user	10.5.28	O (Note 2)	2-131
NOTE 1 – Information elements specific to Q.933 (1995) Case B have been deleted (see Note in 10.1).			
NOTE 2 – This information element is passed on transparently at the NNI.			
NOTE 3 – Included to indicate the final link layer core parameters to use for the SVC.			
NOTE 4 – Included if it was included by the called user/DTE at the called UNI/DTE-DCE interface.			
NOTE 5 – This information element may be repeated to identify multiple networks. See 10.6.9.1.			
NOTE 6 – A maximum of 10 instances of this information element may be present.			

10.4.4 Progress

The Progress message is no longer supported in this Recommendation (see Note in 10.1).

Table 5/X.76 – PROGRESS message content

(No longer supported)

10.4.5 Release

This message is sent to indicate that the SVC has been cleared and the data link connection identifier and call reference are being released. See Table 6.

Table 6/X.76 – RELEASE message content

Message type: RELEASE		Direction: Both	
Significance: Global			
Information element	Reference	Type	Length
Protocol discriminator	10.5.1	M	1
Call reference	10.5.2	M	3
Message type	10.5.3	M	1
Cause	10.5.11	M (Note 1)	2-32
Transit network identification	10.5.26	O (Note 5)	5-11
Clearing network identification	10.5.12	O	5-11
Generic application transport	10.5.17 <i>bis</i>	O (Note 6)	2-257
NOTE 1 – This information element may occur twice to indicate multiple release causes.			
NOTE 2 – Information elements specific to Q.933 (1995) Case B have been deleted (see Note in 10.1).			
NOTE 5 – This information element may be repeated to identify multiple networks. See 10.6.9.1.			
NOTE 6 – A maximum of 10 instances of this information element may be present.			

10.4.6 Release complete

This message is sent to indicate that the SVC has been cleared and the data link connection identifier and call reference has been released. Normally this message is sent as a reply to a RELEASE message. See Table 7.

Table 7/X.76 – RELEASE COMPLETE message content

Message type: RELEASE COMPLETE		Direction: Both	
Significance: Local (Note 7)			
Information element	Reference	Type	Length
Protocol discriminator	10.5.1	M	1
Call reference	10.5.2	M	3
Message type	10.5.3	M	1
Cause	10.5.11	O (Note 1)	2-32
Transit network identification	10.5.26	O (Note 5)	5-11
Clearing network identification	10.5.12	O	5-11
Generic application transport	10.5.17 <i>bis</i>	O (Note 6)	2-257
NOTE 1 – Mandatory if this message is the first clearing message. This information element may occur twice to indicate multiple release causes.			
NOTE 2 – Information elements specific to Q.933 (1995) Case B have been deleted (see Note in 10.1)			
NOTE 5 – This information element may be repeated to identify multiple networks. See 10.6.9.1.			
NOTE 6 – A maximum of 10 instances of this information element may be present if the RELEASE COMPLETE is sent as the first clearing message.			
NOTE 7 – This message has local significance. However, its content has global significance when used as the first call clearing message.			

10.4.7 Restart

This message is sent to initiate restart (i.e., return to an idle condition) the NNI. See Table 8.

Table 8/X.76 – RESTART message content

Message type: RESTART		Direction: Both	
Significance: Local			
Information element	Reference	Type	Length
Protocol discriminator	10.5.1	M	1
Call reference	10.5.2	M (Note)	3
Message type	10.5.3	M	1
NOTE – Only the global call reference value is used with this message.			

10.4.8 Restart acknowledge

This message is sent to indicate that the requested restart has been completed. See Table 9.

Table 9/X.76 – RESTART ACKNOWLEDGE message content

Message type: RESTART ACKNOWLEDGE Direction: Both			
Significance: Local			
Information element	Reference	Type	Length
Protocol discriminator	10.5.1	M	1
Call reference	10.5.2	M (Note)	3
Message type	10.5.3	M	1
NOTE – Only the global call reference value is used with this message.			

10.4.9 Setup

This message is sent by the calling STE to the called STE to initiate SVC establishment. See Table 10.

Table 10/X.76 – SETUP message content

Message type: SETUP		Direction: Forward	
Significance: Global			
Information element	Reference	Type	Length
Protocol discriminator	10.5.1	M	1
Call reference	10.5.2	M	3
Message type	10.5.3	M	1
Bearer capability	10.5.4	M	5
Called party SPVC	A.2	O	5-7
Calling party SPVC	A.3	O	5-6
Data link connection identifier	10.5.16	M	4-6
Link layer core parameters	10.5.19	M	2-31
Link layer protocol parameters	10.5.20	O (Note 2)	2-9
Reverse charging indication	10.5.25	O	3
Priority and service class parameters	10.5.23	O	4-8

Table 10/X.76 – SETUP message content

Message type: SETUP		Direction: Forward	
Significance: Global			
Information element	Reference	Type	Length
Transit network identification	10.5.26	O (Note 3)	5-11
CUG interlock code	10.5.13	O	12-16
Call identification	10.5.5	M	6
Calling party number	10.5.9	M	2-19
Calling party subaddress	10.5.10	O (Note 2)	2-23
Called party number	10.5.7	M	2-18
Called party subaddress	10.5.8	O (Note 2)	2-23
Low layer compatibility	10.5.21	O (Notes 2, 5)	2-16
Generic application transport	10.5.17 <i>bis</i>	O (Note 6)	2-257
User-user	10.5.28	O (Note 2)	2-131
NOTE 1 – Information elements specific to Q.933 (1995) Case B have been deleted (see Note in clause 10.1).			
NOTE 2 – This information element is passed on transparently at the NNI.			
NOTE 3 – Information elements specific to Q.933 (1995) Case B have been deleted (see Note in 10.1).			
NOTE 4 – Information elements specific to Q.933 (1995) Case B have been deleted (see Note in 10.1).			
NOTE 5 – Up to three low layer compatibility information elements may be present.			
NOTE 6 – A maximum of 10 instances of this information element may be present.			

10.4.10 Status

This message is sent in response to a STATUS ENQUIRY or at any time during a call to report certain error conditions. See Table 11.

Table 11/X.76 – STATUS message content

Message type: STATUS		Direction: Both	
Significance: Local			
Information element	Reference	Type	Length
Protocol discriminator	10.5.1	M	1
Call reference	10.5.2	M (Note)	3
Message type	10.5.3	M	1
Cause	10.5.11	M	4-32
Call State	10.5.6	M	3
NOTE – The global call reference may be used with this message.			

10.4.11 Status Enquiry

This message is sent at any time to solicit a STATUS message. See Table 12.

Table 12/X.76 – STATUS ENQUIRY message content

Message type: STATUS ENQUIRY		Direction: Both	
Significance: Local			
Information element	Reference	Type	Length
Protocol discriminator	10.5.1	M	1
Call reference	10.5.2	M (Note)	3
Message type	10.5.3	M	1
NOTE – The global call reference may be used with this message.			

10.5 General message format and information element coding

This clause describes the information elements which are included in the signalling messages defined in the previous subclause.

Every message of this protocol shall consist of the following parts:

- protocol discriminator;
- call reference;
- message type;
- other information elements.

Information elements a), b), c) are common to all the messages and shall always be present. Each message will have additional information elements. This organization is shown in Figure 9.

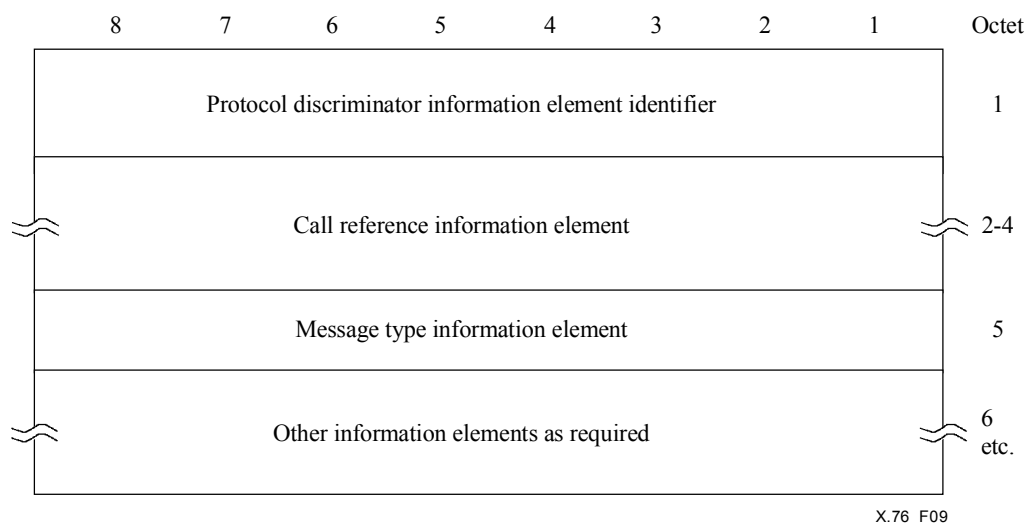


Figure 9/X.76 – General message organization example

Unless specified otherwise, a particular information element may be present only once in a given message.

The following variable length information elements are used for frame relay switched virtual circuit:

Information element	I.E. identifier coding
Bearer capability	0000 0100
Call identification	0110 1001
Call state	0001 0100
Called party number	0111 0000
Called party SPVC	0000 1010
Called party subaddress	0111 0001
Calling party number	0110 1100
Calling party SPVC	0000 1011
Calling party subaddress	0110 1101
Cause	0000 1000
Clearing network identification	0110 1011
Closed user group interlock code	0110 1000
Connected number	0100 1100
Connected subaddress	0100 1101
Data Link Connection Identifier (DLCI)	0001 1001
Generic application transport (Note)	0110 1110
Link layer core parameters	0100 1000
Link layer protocol parameters	0100 1001
Low layer compatibility	0111 1100
Priority and service class parameters	0110 1010
Reverse charging indicator	0100 1010
Transit network identification	0110 0111
User-user	0111 1110

NOTE – Refer to Frame Relay Forum Implementation Agreement FRF.10.1 for the specification of the Generic Application Transport (GAT) information element.

The coding of the information elements other than the first three mandatory information elements (protocol discriminator, call reference and message type) is as follows:

- The information elements used with frame relay call control are of variable length. They are described in alphabetical order. However, there is a particular order of appearance for each information element in a message. The code values of the variable length information element identifiers are assigned in numerical order according to the actual order of appearance of each information element in a message. This allows a receiver to detect the presence or absence of a particular information element without scanning through the entire message.
- Information element identifier values (first octet of a variable length information element) with bits 5-8 coded 0000 are for information elements for which comprehension by the receiver is required.
- When the description of the information elements contains spare bits, these bits are indicated as being set to 0, and are not interpreted on reception.

The second octet of a variable length information element indicates the total length of the contents starting with octet 3. It is the binary coding of the number of octets of the contents, with bit 1 as the least significant bit.

Each octet of a variable length information element is numbered.

Optional octet (s) are marked with asterisks (*).

An octet group is a self-contained entity, it contains one or more octets. For frame relay information elements, the internal structure of an octet group is defined by using the following extension mechanism:

- The first octet of an octet group is identified by a number (N). The subsequent octets are identified as Na, Nb, Nc, etc. Bit 8 of each octet is the *extension bit*. The value 0 of bit 8 indicates that the octet group continues to the next octet. The value 1 of bit 8 indicates that this octet is the last octet of the octet group. If one octet (Nc) must be present, the preceding octets (N, Na and Nb) must also be present.
- In the description of the information elements, bit 8 is marked "0/1 ext." if another octet follows. Bit 8 is marked "1 ext." if this is the last octet of the octet group. In addition to the extension mechanism defined above, an octet N may be extended through the next octets N1, N2, N3, etc. by indications in bits 7-1 of octet N.

When a field extends over more than one octet, the order of bit values progressively decreases as the octet number increases. The least significant bit of the field is represented by the lowest numbered bit of the highest-numbered octet of the field.

10.5.1 Protocol discriminator

The protocol discriminator is the first part (first octet) of every message. It is coded as shown in Figure 10.

8	7	6	5	4	3	2	1	Octet
Protocol discriminator								1
0	0	0	0	1	0	0	0	

Figure 10/X.76 – Protocol discriminator

10.5.2 Call reference

The purpose of the call reference is to identify the switched virtual circuit to which the particular message applies. The call reference does not have end-to-end significance. The call reference is the second part of every message.

The call reference is coded as shown in Figure 11 and Table 13. Only call reference values of two octets (15 bits) are supported in this Recommendation. The encoding of the call reference value always uses two octets even if the value can be encoded in one octet only. Hence, the length field will always have a binary value of 0010. The most significant bit of the call reference value is bit 7 of octet 2 and the least significant bit is bit 1 of octet 3.

The purpose of the call reference flag is to identify who allocated the call reference value for a call. The call reference flag is used to resolve simultaneous attempts to allocate the same call reference value.

The call reference flag can take the binary values 0 or 1. The call reference flag is used to identify which end of the NNI originated a call reference. The origination side always sets the call reference flag to 0. The recipient side always sets the call reference flag to 1.

The call reference value will always have two octets. The call reference value is coded as a 15-bit binary number. A call reference value equal to zero is reserved for the global call reference value. The global call reference has also a length of 2 octets.

Figure 11 | Table 13/X.76 – Call reference information element

Figure 11 – Call reference information element structure

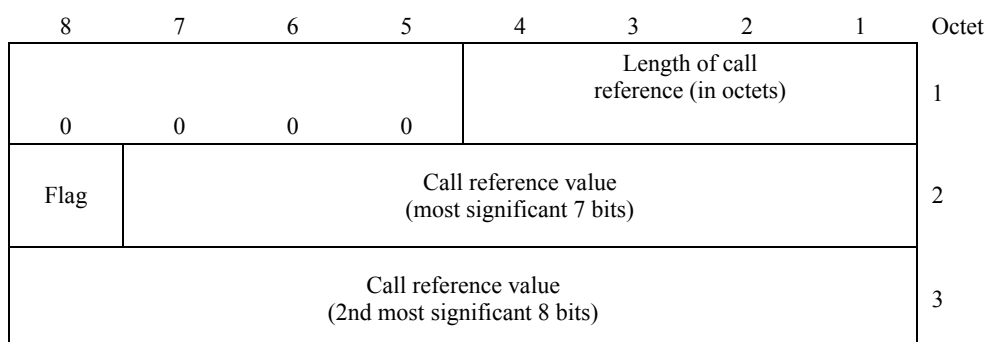


Table 13 – Call reference information element codepoints

<i>Flag (octet 2)</i>	
Bit	
<u>8</u>	
0	The message is sent from the side of the NNI that originates the call reference.
1	The message is sent to the side of the NNI that originates the call reference.

10.5.3 Message type

The following messages are used at the NNI:

<i>Message type</i>	<i>Message type codepoint</i>
CALL PROCEEDING	0000 0010
CONNECT	0000 0111
SETUP	0000 0101
RELEASE	0100 1101
RELEASE COMPLETE	0101 1010
RESTART	0100 0110
RESTART ACKNOWLEDGE	0100 1110
STATUS	0111 1101
STATUS ENQUIRY	0111 0101

10.5.4 Bearer capability

The purpose of the bearer capability information element is to request a bearer service. The only bearer service supported is the frame relay bearer service. The bearer capability information element is coded as shown in Figure 12 and Table 14.

Figure 12 | Table 14/X.76 – Bearer capability information element

Figure 12 – Bearer capability information element structure

8	7	6	5	4	3	2	1	Octet
Bearer capability information identifier								1
0	0	0	0	0	1	0	0	
Length of the bearer capability contents								2
0	0	0	0	0	0	1	1	
ext.	Coding standard		Information transfer capability					3
1	0	0	0	1	0	0	0	
ext.	Transfer mode		Reserved					4
1	0	1	0	0	0	0	0	
ext.	Layer 2 ident.		User information layer 2 protocol					6
1	1	0	0	1	1	1	1	

NOTE – Octet numbering is according to ITU-T Rec. Q.931.

Table 14 – Bearer capability information element codepoints

<i>User information layer 2 protocol (octet 6)</i>	
Bits	
<u>5 4 3 2 1</u>	
0 1 1 1 1 Core aspects of frame mode (see Annex A/Q.922)	
All other values are reserved.	

10.5.5 Call identification

The call identification information element is used to uniquely identify a call. See Figure 13.

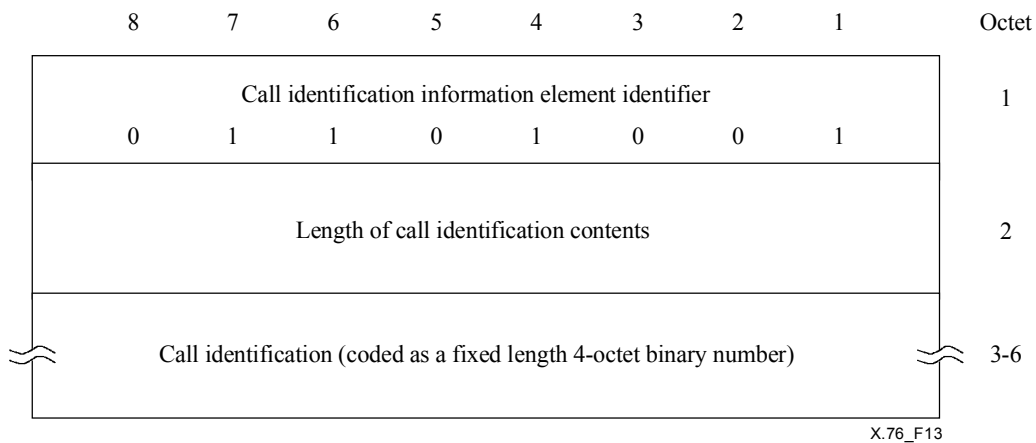


Figure 13/X.76 – Call identification information element

10.5.6 Call state

The call state information element is used to describe the state of a call. See Figure 14 and Table 15.

Figure 14 | Table 15/X.76 – Call state information element

Figure 14 – Call state information element structure

8	7	6	5	4	3	2	1	Octet
Call state information element identifier								1
0	0	0	1	0	1	0	0	
Length of call state contents								2
Coding standard		Call state value (state value is coded in binary)						3
0	0							

Table 15 – Call state information element codepoints

<i>Call state value (octet 3)</i>			
Bits			
<u>6</u>	<u>5</u>	<u>4</u>	<u>3 2 1</u> State
0 0 0	0 0 0	NN0	Null
0 0 0	0 0 1	NN1	Call initiated
0 0 0	0 1 1	NN3	Call proceeding sent
0 0 0	1 1 0	NN6	Call present
0 0 1	0 0 1	NN9	Call proceeding received
0 0 1	0 1 0	NN10	Active
0 0 1	0 1 1	NN11	Release request
0 0 1	1 0 0	NN12	Release indication
0 0 0	0 0 0	Rest0	Null
1 1 1	1 0 1	Rest1	Restart request
1 1 1	1 1 0	Rest2	Restart

10.5.7 Called party number

The purpose of the called party number information element is to identify the called party of a call. See Figure 15 and Table 16.

Figure 15 | Table 16/X.76 – Called party number information element

Figure 15 – Called party number information element

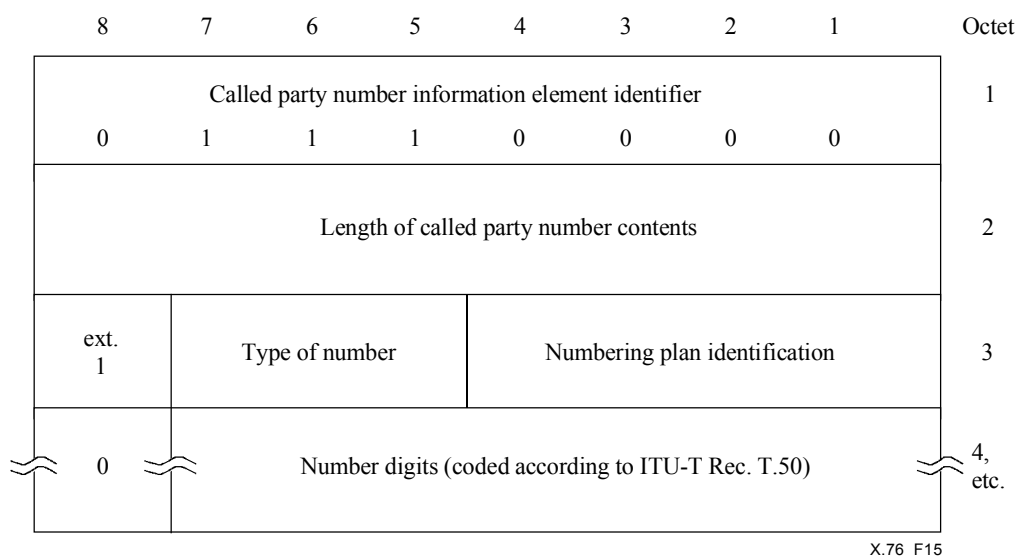


Table 16 – Called party number information element codepoints

Type of number (octet 3)

Bits

7 6 5

0 0 1 International number (Note 1)

1 0 1 Alternative address (Note 2)

All other values are reserved.

NOTE 1 – Prefix or escape digits shall not be included in the number digits.

NOTE 2 – This codepoint is used in conjunction with the coding of an NSAP format called party number of an ATM end system. See also numbering plan identification.

Numbering plan identification (octet 3)

Bits

4 3 2 1

0 0 0 1 ISDN/telephony numbering plan (ITU-T Rec. E.164)

0 0 1 1 Data numbering plan (ITU-T Rec. X.121)

0 0 0 1 When the type of number is alternative address, this codepoint indicates ISO NSAP address coded according to Annex A of ITU-T Rec. X.213 | ISO/IEC 8348 and Annex F/X.36.

All other values are reserved.

Table 16 – Called party number information element codepoints

<i>Valid combinations of type of number and numbering plan fields</i>		
TON	NPI	Format
• International	E.164	CC + N(S)N
• International	X.121	DNIC + NTN
• Alternative address	ISO NSAP	AESA (Note 3)

NOTE 3 – This combination is used to allow the addressing of an AESA coded as an NSAP. The support of this combination is subject to bilateral agreements between networks. It is used to provide interworking of frame relay and ATM networks. The use of this combination does not imply that a frame relay network supports the numbering plans or addressing schemes identified in the AESA. It rather allows the selection of a route towards a frame relay/ATM interworking unit.

Number digits (octet 4, etc.)

The number digits appear in multiple octets starting at octet 4. One digit is coded per octet such that the leftmost digit is coded in octet 4. Each digit is coded according to ITU-T Rec. T.50.

10.5.8 Called party subaddress

The purpose of the called party subaddress information element is to identify the subaddress of the called party of the call. This information element is passed on transparently at the NNI. See Figure 16.

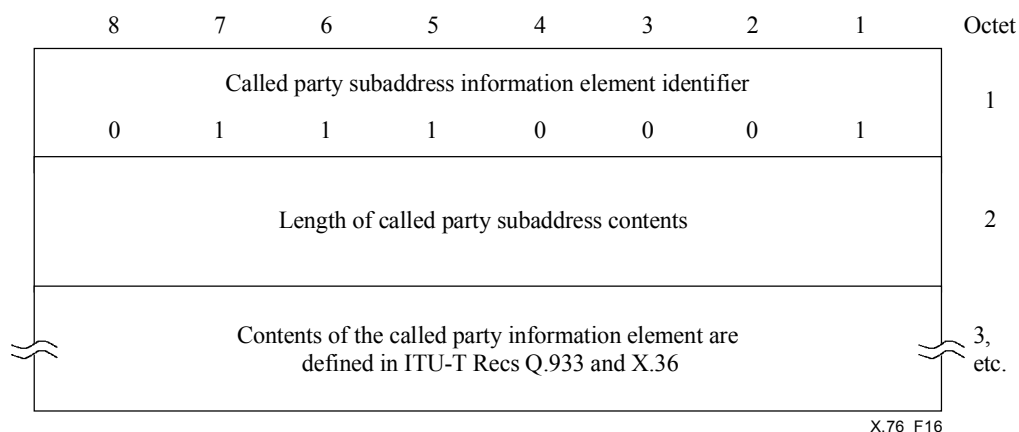


Figure 16/X.76 – Called party subaddress information element

10.5.9 Calling party number

The purpose of the calling party number information element is to identify the origin of a frame relay switched virtual circuit. See Figure 17 and Table 17.