



INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

X.36

(02/2003)

SERIES X: DATA NETWORKS AND OPEN SYSTEM
COMMUNICATIONS

Public data networks – Interfaces

**Interface between Data Terminal Equipment
(DTE) and Data Circuit-terminating Equipment
(DCE) for public data networks providing frame
relay data transmission service by dedicated
circuit**

ITU-T Recommendation X.36

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ITU-T Recommendation X.36

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

Summary

This Recommendation defines the DTE/DCE interface for public data networks providing frame relay data transmission service by dedicated circuit. It defines frame relay basic service for permanent virtual circuits and switched virtual circuits and frame relay link layer protocol for data transfer. It defines permanent virtual circuits management protocol and signalling for switched virtual circuits. It also defines the following network capabilities: closed user group, reverse charging, transit network selection, transfer and discard priorities and service classes, NSAP support by the network for interworking with ATM networks, multiprotocol encapsulation and selection and fragmentation at the DTE/DCE interface. This revision replaces ITU-T Rec. X.36 (2000); it has a new annex explaining the relationship between clause 11 on PVC management procedures and Annex A of ITU-T Rec. Q.933 and a new appendix imported from ITU-T Rec. Q.933.

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

Source

ITU-T Recommendation X.36 was revised by ITU-T Study Group 17 (2001-2004) and approved under the WTSA Resolution 1 procedure on 13 February 2003.

FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

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In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

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

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ITU-T Recommendation X.36

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

1 Scope

This Recommendation defines the 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. It defines frame relay basic service for permanent virtual circuits and switched virtual circuits and frame relay link layer protocol for data transfer. It defines permanent virtual circuits management protocol and signalling for switched virtual circuits. It defines also the following network capabilities:

- Closed user group;
- Reverse charging;
- Transit network selection;
- Support of NSAP;
- Transfer and discard priorities;
- Service classes;
- Fragmentation at the DTE/DCE interface;
- Multiprotocol encapsulation and selection.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of currently valid ITU-T Recommendations is regularly published. 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 (1997), *The international public telecommunication numbering plan*.
- 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 G.707/Y.1322 (2000), *Network node interface for the synchronous digital hierarchy SDH*.
- ITU-T Recommendation G.732 (1988), *Characteristics of primary PCM multiplex equipment operating at 2048 kbit/s*.
- ITU-T Recommendation I.122 (1993), *Framework for frame mode bearer services*.
- ITU-T Recommendations I.233.x series, *Frame mode bearer services*.

- ITU-T Recommendation I.363.5 (1996), *B-ISDN ATM Adaptation Layer specification: Type 5 AAL*.
- 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 the Signalling System No. 7 ISDN user part*.
- 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 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.21 (1992), *Interface between Data Terminal Equipment and Data Circuit-terminating Equipment for synchronous operation on public data networks*.
- ITU-T Recommendation X.21 bis (1988), *Use on public data networks of Data Terminal Equipment (DTE) which is designed for interfacing to synchronous V-series modems*.
- ITU-T Recommendation X.25 (1996), *Interface between Data Terminal Equipment (DTE) and Data Circuit-terminating Equipment (DCE) for terminals operating in the packet mode and connected to public data networks by dedicated circuit*.
- ITU-T Recommendation X.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.144 (2000), *User information transfer performance parameters for data networks providing international frame relay PVC service*.
- ITU-T Recommendation X.146 (2000), *Performance objectives and quality of service classes applicable to frame relay*.

- ITU-T Recommendation X.150 (1988), *Principles of maintenance testing for public data networks using Data Terminal Equipment (DTE) and Data Circuit-terminating Equipment (DCE) test loops*.
- ITU-T Recommendation X.263 (1998) | ISO/IEC TR 9577:1999, *Information technology – Protocol identification in the Network layer*.
- ISO/IEC 646:1991, *Information technology – ISO 7-bit coded character set for information interchange*.
- 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 Terms and definitions

This Recommendation defines the following terms:

3.1 calling/called DTE: A calling DTE is the entity which initiates or originates a request to set up a Frame Relay switched virtual circuit. The called DTE is the DTE to which a Frame relay switched virtual circuit set-up request is directed.

3.2 connected DLCI: A DLCI is "connected" when it is being used in a frame relay switched virtual circuit.

3.3 disconnected DLCI: A DLCI is "disconnected" when it is no longer being used in a frame relay switched virtual circuit but is not yet available for use in a new frame relay switched virtual circuit.

3.4 released DLCI: A DLCI is "released" when it is not being used in a frame relay switched virtual circuit but is available for use in a new frame relay switched virtual circuit.

3.5 outgoing/incoming (first meanings): In relation to call establishment and the call state machines at a DTE/DCE interface, the term "outgoing" refers to the direction from the DTE to the DCE at the originating DTE/DCE interface. The term "incoming" refers to the direction from the DCE to the DTE at a destination DTE/DCE interface. In this context, the meanings of "outgoing" and "incoming" are local to a DTE/DCE interface.

3.6 outgoing/incoming (second meanings): The second meanings of "outgoing" and "incoming" are strictly related to the Link layer core parameters and the Priority and service class parameters information elements. In this context, the term "outgoing" refers to the forward direction from the calling DTE to called DTE and the term "incoming" refers to the backward direction from the called DTE to calling DTE.

4 Abbreviations

This Recommendation uses the following abbreviations:

AR	Access Rate
Bc	Committed Burst Size
Be	Excess Burst Size
BECN	Backward Explicit Congestion Notification
CIR	Committed Information Rate
CLLM	Consolidated Link Layer Management
CLNP	Connectionless Network Layer Protocol

C/R	Command/Response
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
EIR	Excess Information Rate
FCS	Frame Check Sequence
FDDI	Fibre Distributed Data Interface
FECN	Forward Explicit Congestion Notification
FR	Frame Relay
FRDTS	Frame Relay Data Transmission Service
IP	Internet Protocol
LAPF	Link Access Protocol F
MAC	Media Access Control
OUI	Organization Unique Identifier
PDN	Public Data Network
PDU	Protocol Data Unit
PID	Protocol Identifier
PVC	Permanent Virtual Circuit
SNAP	Subnetwork Access Protocol
SVC	Switched Virtual Circuit
Tc	Committed Rate Measurement Interval
VC	Virtual circuit

5 Conventions

No special conventions are employed within this Recommendation.

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

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

6.1 ITU-T X.21 interface

6.1.1 DTE/DCE interface element

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

6.1.2 Procedures for entering operational phases

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

6.1.3 Failure detection and test loops

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

The definitions of test loops and the principles of maintenance testing using the test loops are provided in ITU-T Rec. X.150.

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

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

6.1.4 Signal element timing

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

6.2 X.21 *bis* interface

6.2.1 DTE/DCE physical interface elements

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

6.2.2 Operational phases

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

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

6.2.3 Failure detection and test loops

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

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

6.2.4 Signal element timing

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

6.3 V-series interfaces

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

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

6.4 G-series interfaces

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

When used, the frame structure conforms to ITU-T Rec. G.704. In case of 2 Mbit/s, time slot 0 is used to perform the 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.

A physical layer interface based on SDH shall be according to ITU-T Rec. G.707.

6.5 I-series interfaces

I-series physical interfaces on PDN for Frame Relay Data Network Service are defined in ITU-T Recs I.430 and I.431.

NOTE – I-series physical interfaces are to be used for dedicated lines to the PDN providing a FRDTS. In some cases, semi-permanent channel interfaces from ISDN networks will be used without channel negotiation procedures.

7 Description of services

7.1 General definition

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

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

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

7.2 Multiplexing

FRDTS allows simultaneous connections between DTEs to be multiplexed on a single access circuit. Individual frames of a given connection are identified by means of an attached label. This field in the frame called DLCI (Data Link Connection Identifier) is a logical identifier, with local significance. The network keeps a relationship between the DLCI used on one DTE/DCE interface and the DLCI used on the remote DTE/DCE interface for a given DTE to DTE connection (see Figure 7-1). Note that the mapping of DLCI value of transmitting DTE to receiving DTE is network dependent.

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

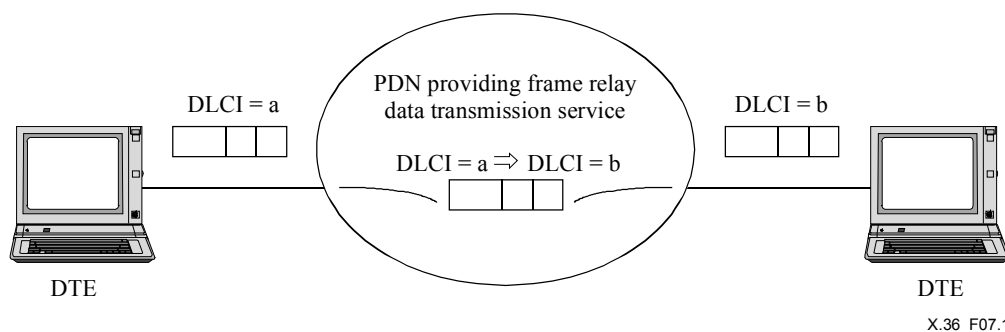


Figure 7-1/X.36 – Data Link Connection Identifier

7.3 Service aspect

FRDTS provides both Switched Virtual Circuit (SVC) and Permanent Virtual Circuit (PVC) services.

7.4 Frame transfer priority

7.4.1 General description

The frame transfer priority is an optional network facility allowing networks and DTEs the possibility to apply different priorities to virtual circuits. During the data transfer phase, a virtual circuit with a higher frame transfer priority will have, in general, its frames serviced (processed and transmitted) before the frames of virtual circuits assigned a lower priority resulting in a lower end-to-end delay and lower variation of this delay. Frame transfer priorities are assigned per virtual circuit and possibly for each direction of the data transmission. Frame transfer priority provides frame relay networks with a capability allowing them to support and meet the temporal requirements, such as end-to-end delay, of real-time applications and to offer multiple level of services based on the time-sensitivity requirements of the applications.

7.4.2 Service provisioning and request

Supporting the frame transfer priority service during the data transfer phase is a network option. If supported, it is also a network option whether the frame transfer priority applies at the DTE/DCE interface and/or within the network and if different frame transfer priorities per data transmission direction are possible or not. If a network does not support different frame transfer priorities for each direction, the highest requested priority is used for both directions.

For permanent virtual circuits, frame transfer priority is assigned at subscription time. For switched virtual circuit subscription parameters may be required to manage by the networks the usage of frame transfer priorities. Frame transfer priority is requested by the calling DTE, the request is processed by the network and transmitted to the called DTE. When progressing the call set-up, the network accommodates the request of the calling DTE based on its own Frame transfer priority capabilities.

When using a permanent or switched virtual circuit with frame transfer priority requested to the network, a DTE is encouraged to also apply frame transfer priority when it transmits data to the network or, if applicable, when it switches data internally.

A condition for frame transfer priority services to provide their expected benefits is such that DTEs do not always use the same priority (possibly the highest one).

It is the responsibility of network operators to build mechanisms that will lead DTEs to request different frame transfer priority. Such mechanisms could be based on items or combination of items of the following non-exhaustive and non-constraining list, items defined for a DTE/DCE interface and per priority class:

- a different tariff;
- a maximum number (Note 1) of VCs (PVCs + SVCs) per interface;
- a maximum limit to frame information field size per VC;
- a maximum limit (Note 1) to sum of CIR, aggregated per interface;
- a maximum limit (Note 1) to sum of (CIR + EIR) (Note 3), aggregated per interface;
- a maximum limit (Note 1) to sum of Committed burst size (Bc), aggregated per interface;
- a maximum limit (Note 1) to sum of Excess burst size (Be), aggregated per interface;
- a maximum limit (Note 2) to individual CIR, i.e., per VC;
- a maximum limit (Note 2) to individual (CIR + EIR) (Note 3), i.e., per VC;
- a maximum limit (Note 2) to individual Committed burst size (Bc), i.e., per VC;
- a maximum limit (Note 2) to individual Excess burst size (Be), i.e., per VC;

NOTE 1 – Actual value can be an absolute figure or a function of access rate of the DTE/DCE interface.

NOTE 2 – Actual value can be an absolute figure or a function based on the minimum of access rates of the two considered DTE/DCE interfaces.

NOTE 3 – $CIR + EIR = CIR (1 + Be/Bc)$.

Regarding traffic policing based on link layer core parameters, different behaviours may exist based on frame transfer priority classes (possibly more constraining on highest one) in case CIR and EIR are exceeded.

7.4.2.1 Frame transfer priority indices and classes

A frame transfer priority class corresponds to a distinct frame transfer priority supported by the network. The number and characteristics of frame transfer priority classes rely highly on internal network capabilities and as such cannot be standardized.

A frame transfer priority index is an integer from zero to fifteen used at the DTE/DCE interfaces to identify a frame transfer priority. Zero is the lowest priority index and fifteen the highest. The mapping between frame transfer priority indices and classes is network-dependent. A frame transfer priority index has a local significance. Therefore, it has a local meaning determined according to the service description of the network a DTE is connected to.

7.4.2.2 Conformance to the Frame transfer priority service

In order to conform to the Frame transfer priority service, a network must ensure that its mapping between frame transfer priority indices and classes always satisfies the following proposition:

Let i and j be two indices with $i < j$ then $FTP_Class(i) \leq FTP_Class(j)$.

In other words if i and j are two frame transfer priority indices such that i is smaller than j , the frame transfer priority class (FTP_Class) assigned to a switched virtual circuit requesting a frame transfer priority index equal to i shall not be greater than the frame transfer priority class assigned by the network to a virtual circuit requesting a frame transfer priority index equal to j . It may, however, be the same.

In addition a network must ensure that if $FTP_Class(j) > FTP_Class(i)$ the temporal constraints or performance bounds such as delays and/or delay variation assigned to $FTP_Class(j)$ are better than those assigned to $FTP_Class(i)$. This Recommendation does not specify what is meant by "better" nor shall it specify specific performance bounds. This is the prerogative of the service provider. Intuitively, it should be expected that a higher FTP_Class will support a lower delay and/or lower delay variation.

7.5 Frame discard priority

7.5.1 General description

The frame discard priority at the DTE/DCE interface is an optional network facility. It allows networks and DTEs to apply different frame discard priorities to virtual circuits at the DTE/DCE interface. Each discard priority can be associated with a different frame loss ratio. When frame relay frames have to be discarded under adverse network conditions, frames belonging to a virtual circuit assigned a lower frame discard priority will be discarded by the network prior to those belonging to virtual circuits assigned higher frame discard priorities. Frame discard priorities are assigned per virtual circuit at the DTE/DCE interface and different values may be assigned for each direction of data transmission.

7.5.2 Service Provisioning and Signalling

Supporting the frame discard priority service is a network option. It is also a network option to support a different frame discard priority per direction of data transmission. If a network does not support different frame discard priorities for each direction, the highest requested priority is used for both directions.

For permanent virtual circuits, Frame discard priority is assigned at subscription time. For switched virtual circuit subscription parameters may be required to manage by the networks the usage of frame discard priorities. Frame discard priority is requested by the calling DTE, the request is processed by the network and transmitted to the called DTE. When progressing the call set-up, the network accommodates the request of the calling DTE based on its own frame discard priority capabilities.

Although the assignment of frame discard priority is different between switched virtual circuits and permanent virtual circuits, its operation is similar during the data transfer phase.

It is the responsibility of network operators to build mechanisms that will lead DTEs to request different frame discard priorities. Such mechanisms could be based on items or combinations of items of the following non-exhaustive and non-constraining list. Items defined for a DTE/DCE interface and per priority are:

- A different tariff;
- A maximum number (Note 1) of VCs (PVCs + SVCs) per interface;
- A maximum limit to frame information field size per VC;
- A maximum limit (Note 1) to sum of CIR, aggregated per interface;
- A maximum limit (Note 1) to sum of (CIR + EIR) (Note 3), aggregated per interface;
- A maximum limit (Note 1) to sum of Committed burst size, aggregated per interface;
- A maximum limit (Note 1) to sum of Excess burst size, aggregated per interface;
- A maximum limit (Note 2) to individual CIR, i.e., per PVC;
- A maximum limit (Note 2) to individual (CIR + EIR) (Note 3), i.e., per VC;
- A maximum limit (Note 2) to individual Excess burst size, i.e., per VC.

NOTE 1 – Actual value can be an absolute figure or a function of access rate of the DTE/DCE interface.

NOTE 2 – Actual value can be an absolute figure or a function based on the minimum of access rate of the two considered DTE/DCE interfaces.

NOTE 3 – $CIR + EIR = CIR (1 + Be/Bc)$.

Regarding traffic policing based on link layer core parameters, different behaviours may exist based on frame discard priority classes (possibly more constraining on highest one) in case CIR and EIR are exceeded.

7.5.2.1 Frame discard priority indices and classes

A Frame discard priority class corresponds to a distinct frame discard priority supported by the network. The number and characteristics of frame discard priority classes rely highly on internal network capabilities and as such cannot be standardized.

A frame discard priority index is an integer from zero to seven used at the DTE/DCE interface to signal a frame discard priority:

- Frame discard priority 0: Lowest frame discard priority. Virtual circuits assigned this frame discard priority will have their frames discarded first. This should result in the highest frame loss ratio.
- Frame discard priority 7: Highest frame discard priority. Virtual circuits assigned this frame discard priority will have their frames discarded last. This should result in the lowest frame loss ratio.

Frame discard priority indices can be grouped into frame discard priority classes within a network, each of which corresponds to a distinct frame discard priority. A frame discard priority index has a local significance. It has a local meaning determined according to the service description of the network a DTE is connected to.

7.5.2.2 Conformance to the frame discard priority service

In order to conform to the frame discard priority service, a network must ensure that its mapping between frame discard priority indices and classes always satisfies the following propositions:

Let i and j be two frame discard priority indices with $i < j$
then $\text{FDP_Class}(i) \leq \text{FDP_Class}(j)$

In other words if i and j are two frame discard priority indices such that i is smaller than j , the frame discard priority class (FDP_Class) assigned to a virtual circuit requesting a frame discard priority index equal to i shall not be greater than the frame discard priority class assigned by the network to a virtual circuit requesting a frame discard priority index equal to j . It may, however, be equal (if i and j map to the same frame discard priority class).

In addition, a network must ensure that if $\text{FDP_Class}(j) > \text{FDP_Class}(i)$, the performance bound such as frame loss ratio assigned to $\text{FDP_Class}(j)$ is better than that assigned to $\text{FDP_Class}(i)$. This Recommendation does not specify what is meant by «better», nor does it define specific performance bounds. This is the prerogative of the service provider. Intuitively, it should be expected a higher FDP_Class would support a lower frame loss ratio.

7.5.3 Frame discard priority and other frame relay parameters

While both frame discard priority and the frame relay discard eligibility (DE) bit deal with frame discards, they function differently but in a complementary manner. At a given point in time when a network supporting multiple virtual circuits of different frame discard priority classes decides to discard frames due to congestion, all frames with DE bits ON (called EIR traffic/frames) regardless of the frame discard priority classes assigned to the connections they belong to, are discarded ahead of frames with DE bit OFF (called CIR traffic/frames). In other words, EIR traffic is treated as the least critical traffic and is discarded first. In the event of continuing congestion, if necessary, CIR frames are then discarded according to their assigned frame discard priorities: CIR frames belonging to connections with lower frame discard priority values will be discarded ahead of those belonging to connections with higher frame discard priority values.

7.6 Frame relay service class

Frame Relay Service Class is an optional facility allowing Frame Relay networks to apply different Quality of Service Classes to Frame Relay virtual circuits to meet delay and loss requirements for different applications. During the data transfer phase, frames will be processed such that the performance characteristics of the subscribed or requested Service Class will be met.

The use of Frame Relay Service Class at the DTE/DCE interface is by subscription for a PVC or by signalling for SVCs. For SVCs, the Service Class is requested by the calling DTE by signalling a service class number at the time of call establishment.

Defined Service Classes are specified in Table 7-1. Each Service Class has associated maximum end-to-end delay and loss values as appropriate for the requirements of applications for each class. Service Classes and their defined delay and loss parameter values are defined in ITU-T Rec. X.146.

Table 7-1 /X.36 – Service class description

Service class number	Support requirement	Application notes
0	Mandatory	Moderate frame loss and unspecified delay requirements.
1	Mandatory	Default Service Class. All Frame Relay networks offering Service Classes will provide this Service Class and the signalling of this Service Class for SVCs if supported. Moderate frame loss and moderate delay requirements.
2	Optional	Stringent frame loss and moderate delay requirements.
3	Optional	Stringent frame loss and stringent delay requirements.

7.7 Support of both service class and priorities

Networks may support Service Class, Priorities, both or none.

Networks will make known by administrative means whether Service Classes, Priorities, or both, are available at a DTE/DCE interface.

In the case where a network provides both options, two modes of operation are possible:

- An optional DTE subscription option that indicates whether the DTE supports Service classes or priorities.
- No DTE subscription.

In any case, on a per PVC or on a per SVC basis network supports either service class or Priority(ies) but not both at the same time on the same PVC or SVC.

7.8 SVC related services

As basic and mandatory features, networks provide calling party number and connected party number screening and presentation as well as link layer core parameter negotiation.

As optional services, networks may provide Closed User Group facilities, Transit network selection facility and reverse charging facility.

8 Service parameters and service quality

8.1 Scope

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

8.2 Service parameters

8.2.1 Access Rate (AR)

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

8.2.2 Committed Burst Size (Bc)

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

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

8.2.3 Excess Burst Size (Be)

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

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

8.2.4 Committed Information Rate (CIR)

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

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

8.2.5 Committed Rate Measurement Interval (T_c)

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

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

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

The size of the Frame Relay Information Field (N203 parameter) is the number of user data octets after the address field and before the Frame Check Sequence (FCS) field (see Figure 9-1). The count is done prior to zero-bit insertion on the transmitting side and following zero-bit extraction at the receiving side. The value of the N203 parameter for a given direction of transmission (i.e., outgoing direction from the DTE to the DCE and incoming direction from the DCE to the DTE) is set to a value selected from a set supported by the network and agreed to for a period of time. The value of the N203 parameter for a given direction of transmission can also be negotiated at call set-up.

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

8.2.7 Priorities or service class

When supported by the network, Frame Transfer and/or Discard Priorities or Service Class are applied on a per virtual circuit basis.

8.2.8 Fragmentation parameters

The use of DTE/DCE fragmentation is defined by a subscription parameter.

In which case, another subscription parameter defines the maximum Fragment size that can be used at the DTE/DCE interface. This parameter applies to both directions of data transmission.

8.3 SVC related service parameters

The mode of operation of SVC requires the introduction of parameters that are generally relevant on a per interface basis. The actual definition of those parameter may be on a per network basis (the same value applies to all interfaces) or on a per interface basis (value is defined as a subscription parameter).

8.3.1 DTE address

DTE address is a succession of digits that uniquely identify the DTE/DCE interface within the numbering plan of the network.

8.3.2 Maximum number of SVCs

This parameter defines the maximum number of SVCs that can simultaneously be established over a DTE/DCE interface, regardless of the direction of each individual call.

8.3.3 Default values for link layer core parameters

To avoid the calling DTE to specify each link layer core parameter, default values are defined:

- outgoing and incoming throughputs (CIR);
- outgoing and incoming minimum throughputs;
- outgoing and incoming committed burst sizes;
- outgoing and incoming excess burst sizes.

Default values for the incoming link layer core parameters can be the same as the default values for the outgoing parameters.

8.3.4 CUG profile

CUG profile of a DTE/DCE interface is determined at subscription time by the set of Closed User Groups to which the interface belongs to (none, one or several), the signalling procedure used (simple CUG versus CUG selection), the mapping of signalled indexes to administrative CUG identifiers in case of CUG selection facility, possible outgoing access and incoming access options.

8.3.5 Reverse charging prevention

The Reverse charging prevention requires the network not to present the reverse charging request to the called DTE.

8.3.6 Default priorities

To avoid the calling DTE to specify each priority, default values are defined:

- outgoing and incoming Frame Transfer priorities;
- outgoing and incoming Frame Discard priorities.

Default values for the incoming priorities can be the same as the default values for the outgoing priorities.

8.3.7 Priorities versus service class

When network supports both Priorities and Service Class, the DTE profile can be subscribed to specify signalling handling of the network on that particular DTE/DCE interface.

8.4 Service quality

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

More details on this aspect can be found in ITU-T Rec. X.144. Congestion occurrence within the network or at the DTE/DCE interfaces impacts the provided QoS level (see clause 12).

Frame Transfer priorities, Frame Discard Priorities and Service classes have an impact on the probability that committed and excess traffics are delivered and on the probability that committed and excess traffics are delivered within a certain delay.

For priorities the exact impact is not standardized and is network dependent. Impact for Service classes is defined in ITU-T Rec. X.146.

9 Data link transfer control

9.1 General

This clause contains the frame structure, elements of procedure, format of fields and procedures for the operation of the Frame Relay Data Transmission Service for physical interfaces other than SDH. For Frame Relay Data Transmission Service over SDH, clause 9.5 applies. The functions provided by the Frame Relay Data Transmission Service are:

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

9.2 Frame format

The frame format used for individual frame is shown in Figure 9-1.

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) octets								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 9-1/X.36 – Frame format with 2-octet address

9.2.1 Flag sequence

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

9.2.2 Address field

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

9.2.3 Information field

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

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 generating 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 generating 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 clause describes the format of the address field (see Figure 9-2). A frame relay connection is governed by the elements of the address field described in this clause. These elements of the address field provide for the support of congestion management optional procedures which can be found in clause 12. The information field follows the address field.

9.3.2 Address field format

The address field shown in Figure 9-2 contains the address field extension bits, a command/response indication bit, a forward explicit congestion notification bit, a backward explicit congestion notification bit, a discard eligibility indication bit, Data Link Connection Identifier (DLCI) bits and a DLCI extension/Control indication bit (D/C bit). The support of 2 octets address field is mandatory. DTE and DCE may also support address fields with a length of 4 octets. When the network supports address fields with length of 4 octets, the choice of the length is made at a subscription time and is applicable to the entire DTE/DCE interface.

9.3.3 The address field element

9.3.3.1 Address field extension bit (EA bit)

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

9.3.3.2 Command/Response bit (C/R bit)

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

	8	7	6	5	4	3	2	1
Default address field format (2 octets)	Upper DLCI (6 bits)						*	EA 0
	Lower DLCI (4 bits)				FECN	BECN	DE	EA 1
or								
4 octets address field format	8	7	6	5	4	3	2	1
	Upper DLCI (6 bits)							EA 0
	DLCI (4 bits)				FECN	BECN	DE	EA 0
	DLCI (7 bits)							EA 0
	Lower DLCI (6 bits)						D/C 0	EA 1
* Bit intended to support a command/response indication. The coding is application specific (see 9.3.3.2).								
BECN Backward Explicit Congestion Notification								
D/C DLCI Extension/Control Indication Bit								
DE Discard Eligibility Indicator								
DLCI Data Link Connection Identifier								
EA Address Field Extension Bit								
FECN Forward Explicit Congestion Notification								

Figure 9-2/X.36 – Address field format

9.3.3.3 Forward Explicit Congestion Notification Bit (FECN bit)

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

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

9.3.3.4 Backward Explicit Congestion Notification Bit (BECN bit)

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

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

9.3.3.5 Discard Eligibility Indicator Bit (DE bit)

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

9.3.3.6 Data Link Connection Identifier (DLCI)

Depending on the length of the address field, the DLCI can be 10 bits, 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 9-2.

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

Specific values of the DLCI are also used for:

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

The various values for DLCI are specified in Tables 9-1 and 9-2.

Table 9-1/X.36 – DLCI value range when 2 octets address field is used

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

Table 9-2/X.36 – DLCI value range when 4 octets address field is used

DLCI range (23 bits)	Function
0	Signalling
1-15	Reserved
16-991	Virtual circuit identification
992-1007	Layer 2 management of FRDTS used for information related to the network such as the Consolidated Link Layer Management (CLLM) messages (see Annex C)
1008-1022	Reserved
1023	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 octets format is used. It is always set to 0 in this Recommendation. When set to 1, the bits 3 to 8 of this last octet are no longer interpreted as DLCI bits and their use is for further study.

9.4 Transmission consideration

9.4.1 Order of bit transmission

The bits are grouped into octets. The bits of an octet are shown horizontally and are numbered from 1 to 8. Multiple octets are shown vertically and are numbered from 1 to n (see Figure 9-3).

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

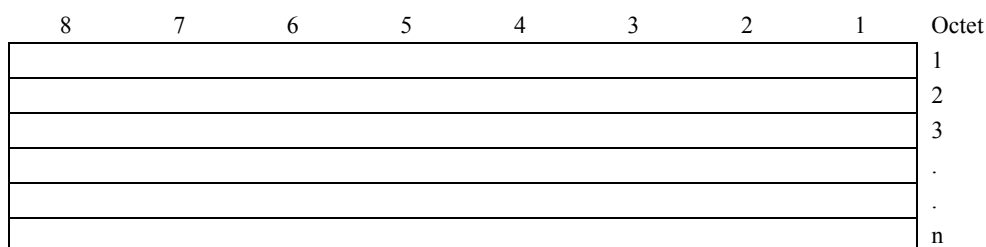


Figure 9-3/X.36 – Format convention

9.4.2 Order of bits in frame fields

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

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

For example in an address field with length of two octets, the order of the values of the DLCI bits is as shown in Figure 9-4.

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

Figure 9-4/X.36 – Order of values of the DLCI bits

There are two exceptions to the preceding convention:

- 1) The order of the values of the bits within the information field is not specified in this Recommendation.
- 2) The order of the values of FCS bits is as follows: bit 1 of the first octet is the high-order bit and bit 8 of the second octet is the low-order bit (see Figure 9-5).

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 9-5/X.36 – Order of values of the FCS bits

9.4.3 Transparency

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

9.4.4 Inter frame fill

For inter frame fill flag sequence must also be used.

9.4.5 Invalid frame

An invalid frame is a frame which:

- a) is not properly bounded by two flags; or
- b) has fewer than two octets between the address field and the closing flag; or
- c) does not consist of an integral number of octets prior to a "0" bit insertion or following "0" bit extraction; or
- d) contains a frame check sequence error; or
- e) contains a single octet address field; or
- f) contains a DLCI which is not supported by the receiver; or
- g) contains 7 or more continuous bits set to 1 after "0" bit insertion or before "0" bit extraction ("transparency violation" or "frame abort"); or
- h) has an information field longer than N203 (see 8.2.6).

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

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

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

9.4.6 Frame abortion

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

9.5 Frame relay data transmission service over SDH

9.5.1 General aspects

Frame relay link layer protocol is a bit-oriented protocol. It was conceived to operate on transmission facilities other than SDH. SDH presents an octet oriented interface to the link layer. There is no provision in SDH to support octet fragments (a number of bits that is not a multiple of 8). In order to cope with SDH requirements, the link layer has to guarantee that an integral number of octets are passed to the physical layer. This is not possible with current frame relay transfer protocol because of the zero bit insertion. The octet oriented frame relay data link layer framing specified in this clause shall be used with SDH as the physical transmission facility.

9.5.2 Framing aspects

Clauses 9.2 to 9.4 apply with the following exceptions:

- 1) Frame check sequence: AAL type 5 described in ITU-T Rec. I.363.5 32-bit FCS shall be used. The FCS generating polynomial is: $G(x) = x^{32} + x^{26} + x^{23} + x^{22} + x^{16} + x^{12} + x^{11} + x^{10} + x^8 + x^7 + x^5 + x^4 + x^2 + x + 1$. The algorithms used by the transmitter and the receiver are defined in ITU-T Rec. I.363.5.
- 2) Transparency: After computation of the FCS, the transmitting DTE or DCE shall examine the contents of the frame between the opening and closing flags (address, information and FCS fields). It shall insert the following binary number escape code 01111101 if a flag sequence (01111110) or an escape code (01111101) is encountered in the contents of the frame. Before FCS computation, the receiving DTE or DCE shall examine the contents of the frame between the two flags, if an octet is preceded by the escape code, the escape code is removed.
- 3) Scrambling as per ITU-T Rec. G.707/Y.1322 is used.

9.6 Fragmentation

This clause provides optional support for transmitting Frame Relay DTEs and DCEs with the ability to fragment long frames into a sequence of shorter frames, which will then be reassembled into the original frame by the receiving peer DTE or DCE.

To properly support delay-sensitive traffic on low-speed virtual connections, it is necessary to fragment the longer, more delay-tolerant frames that share the same connections. This is done so that the shorter, delay sensitive frames are not excessively delayed. Fragmentation is strictly local to the DTE/DCE interface, and the fragment size can be optimally configured to provide the proper delay and delay variation based upon the logical speed of the DTE/DCE interface.

Since fragmentation is local to the interface, the network can take advantage of the higher internal trunk speeds by transporting the complete frames, which is more efficient than transporting a larger number of smaller fragments.

The DTE and DCE interfaces act as fragmentation and reassembly peers, as shown in Figure 9-6.

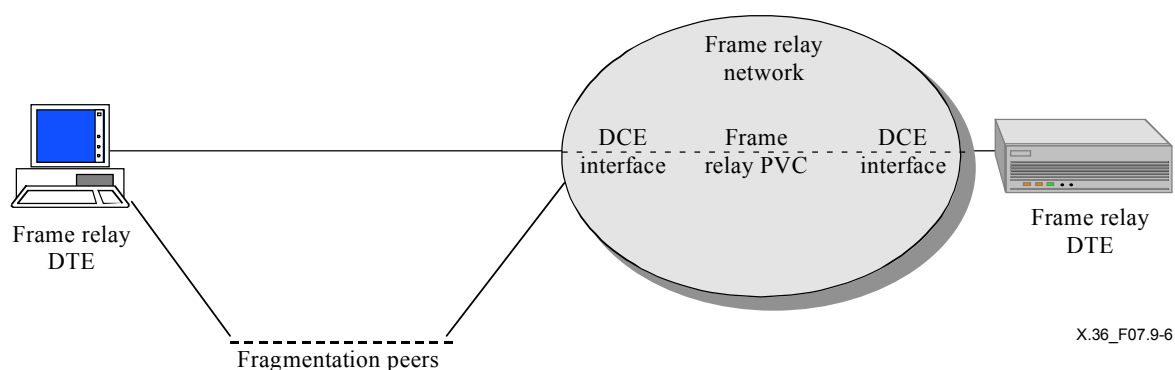


Figure 9-6/X.36 – DTE-DCE fragmentation/reassembly reference diagram

It should be noted that the fragmentation function has been illustrated as a standalone "Logical Fragmentation Function", but it is expected to be implemented in the DTE and DCE interfaces shown in Figure 9-6.

Fragmentation is provisioned on an interface-by-interface basis. When configured on an interface, then fragmentation procedures and format apply to all frames on all DLCIs (including DLCI 0, PVCs, and SVCs).

A subscription parameter defines the maximum Fragment size that can be used at the DTE/DCE interface. This parameter applies to both directions of data transmission.

9.6.1 Fragmentation format

A two-octet fragmentation header is inserted between the opening flag and the address field of the Frame Relay Frame.

The format for each fragment of a Frame Relay frame is described in Figure 9-7.

8	7	6	5	4	3	2	1	Octet
0	1	1	1	1	1	1	0	1
B	E	C	Fragment sequence number (most significant 4 bits)				1	2
Fragment sequence number (less significant 8 bits)								3
Address field first octet								4
Address field second octet								5
Fragment payload								8
								N – 3
Frame check sequence first octet								N – 2
Frame check sequence second octet								N – 1
0	1	1	1	1	1	1	0	N

Figure 9-7/X.36 – Access fragment format

The (B)eginning fragment bit is a one-bit field set to 1 on the first fragment derived from the original frame and set to 0 for all other fragments from the same frame.

The (E)nding fragment bit is a one-bit field set to 1 on the last fragment and set to 0 for all other fragments. A fragment may have both the (B)eginning and (E)nding fragment bits set to 1.

The (C)ontrol bit is set to 0 in all fragments. It is reserved for future control functions.

The fragment sequence number is a 12-bit binary number that is incremented modulo 2^{12} for every fragment transmitted on a VC. There is a separate sequence number maintained for each VC across the DTE/DCE interface.

Note that the low order bit of the first octet of the fragmentation header is set to 1. This allows the fragmentation header to be distinguishable from the Frame Relay header. This allows a fragmentation entity to detect the misconfiguration of its peer, since the peers must be configured identically to use or not use fragmentation across an interface. If a peer is configured for access fragmentation and receives frames that do not contain the fragmentation header, those frames are discarded. If a peer is not configured for access fragmentation and receives frames with the fragmentation header, those frames will be discarded due to the violation of the Frame Relay header format.

9.6.2 Fragmentation procedures

Fragmentation applies to the Information field of the FR frames to be transmitted over the DTE/DCE interface.

A series of Fragments is created by dividing the Information field of a FR frame into fragment payloads. Each resulting fragment payload is transmitted over its intended VC using the fragment format described in Figure 9-7.

All fragments are variable in size.

The transmitter should not exceed the subscribed fragment maximum size.

The resulting fragments must be transmitted in the same sequence as they occurred in the frame prior to being fragmented. Fragments from multiple VCs may be interleaved with each other on one interface.

The first fragment in the series has the B bit set, and the final fragment has the E bit set. Every fragment in the series contains the same address octets that were on the original unfragmented frame, including the Frame Relay congestion bits (FECN, BECN, DE).

The first fragment sent on a VC (following a VC becoming active) may have the sequence number set to any value (including zero), and the sequence number must subsequently be incremented by one for each fragment sent. The sequence number is incremented without regard to the original frame boundaries; if the last fragment in one frame used sequence number "N", then the first fragment of the following frame will use sequence number "N+1". This allows lost fragments (and bursts of lost fragments) to be easily detected. Each VC has its own fragmentation sequence number sequence, independent of all other VCs.

If sufficient fragments are sent on an active VC, the sequence number will wrap from all ones to zero, and will eventually also wrap past the original sequence number sent on the VC after it became active.

9.6.3 Reassembly procedures

For each VC, the receiver must keep track of the incoming sequence numbers and maintain the most recently received sequence number. The receiver detects the end of a reassembled frame when it receives a fragment bearing the (E)nding bit. Reassembly of the frame is complete if all sequence numbers up to that fragment have been received.

Note that the Frame Relay congestion bits (FECN, BECN, DE) must be logically ORed for all fragments, and the results included in the reassembled frame.

The receiver detects lost fragments when one or more sequence numbers are skipped. When a lost fragment or fragments are detected on a VC, the receiver must discard all currently unassembled and subsequently received fragments for that VC until it receives the first fragment that bears the (B)eginning bit. The fragment bearing the (B)eginning bit is used to begin accumulating a new frame.

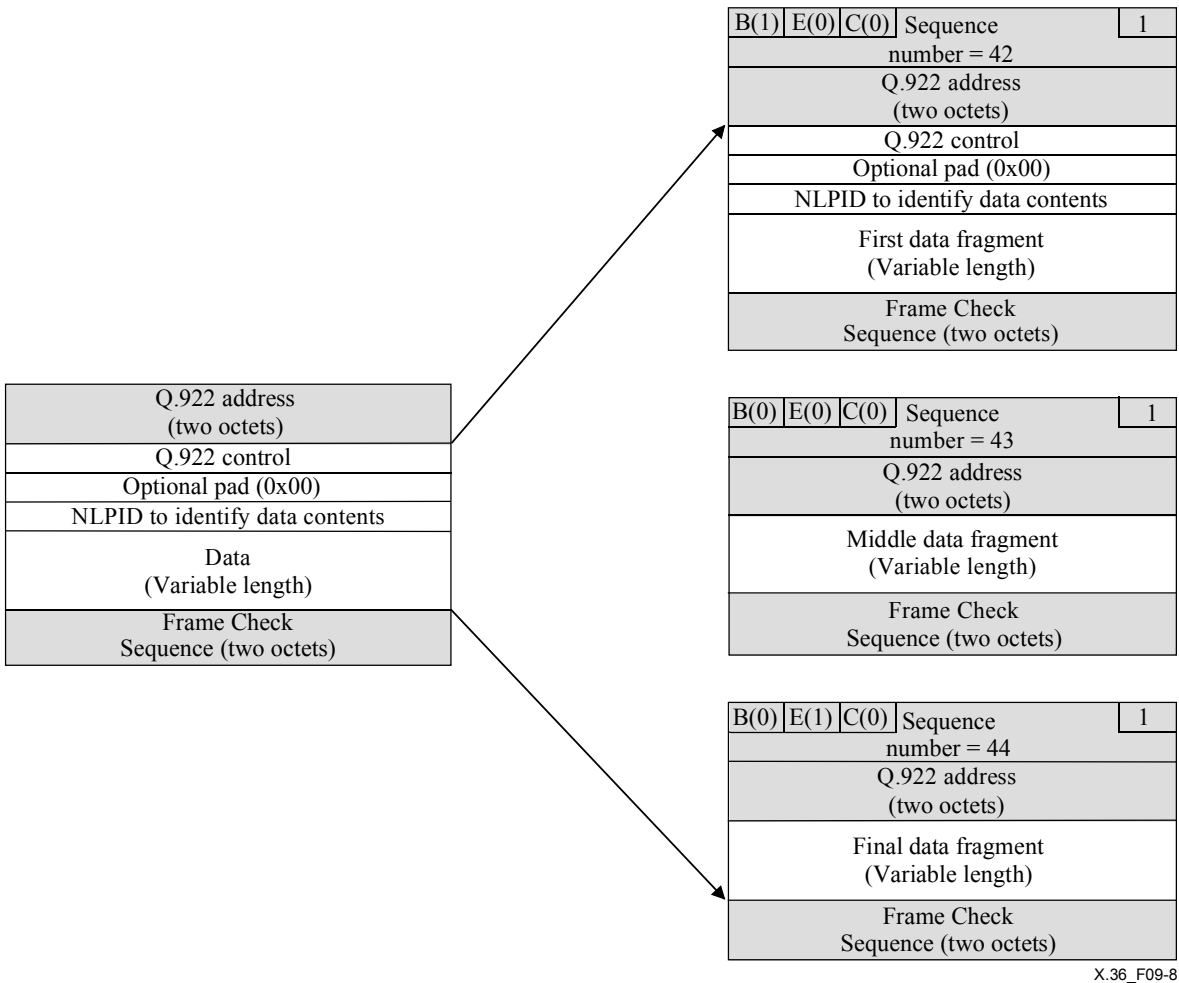
In the event of an error (e.g., one or more fragments lost due to transmission error or reassembly buffer overflow), fragments which cannot be reconstructed back into the original frame must be discarded by the receiver.

In case a fragment exceeds the subscribed maximum Data Fragment size, this fragment, and as a result the following and received fragments of the FR frame being reassembled, should be discarded, by the receiver.

In case it has an information field longer than N203, the reassembled FR frame should be discarded.

9.6.4 Example of operation

An example of the fragmentation procedure, using a multiprotocol encapsulated frame as the data to be fragmented, is diagrammed in Figure 9-8. The octets in white indicate the data portion of the original frame that is split into fragments (three fragments in this example). While this example uses a multiprotocol encapsulated frame for illustration purposes, any arbitrary frame contents may be fragmented. For this example, the starting sequence number of 42 was chosen at random.



X.36_F09-8

Figure 9-8/X.36 – DTE-DCE fragmentation example

10 Call connection control

10.1 General

This clause defines the signalling for frame relay Switched Virtual Circuits (SVCs) control at the DTE/DCE interface of a public data network providing a frame relay service. The following optional facilities also are defined: Closed user group, reverse charging indication and prevention and transit network selection.

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 DTE/DCE interface (see Figure 10-1).

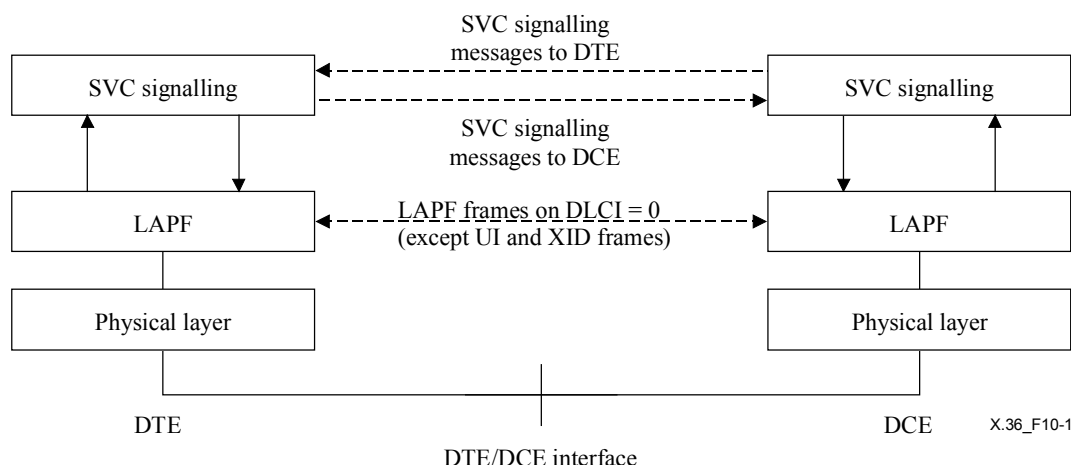


Figure 10-1/X.36 – DTE/DCE protocol layers for signalling

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;
- Disconnection (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 DTE/DCE interface, a LAPF link has to be established using DLCI = 0. After establishment of LAPF link, the data link connection identified with DLCI = 0 is automatically ready for the exchange of the signalling messages across the DTE/DCE interface. 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.

10.3 List of the signalling channel link layer parameters

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

- 1) Timer T200: The default value of 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; its default value is 30 seconds.
- 3) Maximum number of retransmissions N200: The retransmission counter N200 identifies the maximum number of retransmissions of a frame; its default value is 3.
- 4) Maximum number k of outstanding I frames: The default maximum number k of outstanding sequentially numbered I frames (that is, unacknowledged) at any given time shall be 7.
- 5) Maximum number of octets in an Information field: The default for the number of octets N201 in an information field is 1598 ($N203 - 2$) octets.

10.4 Call states

10.4.1 Call states at the DTE side

The following states are the DTE states that may exist at the DTE side of the DTE/DCE interface, (the states have local significance):

- **Null (U0)** – No switched virtual circuit exists.
- **Call Initiated (U1)** – This state exists for an outgoing switched virtual circuit when the DTE has sent a request to the DCE to establish a frame relay switched virtual circuit.
- **Outgoing Call Proceeding (U3)** – This state exists for an outgoing switched virtual circuit when the DTE has received an indication that the DCE has received the necessary information to establish the frame relay switched virtual circuit.
- **Call Present (U6)** – This state exists for an incoming switched virtual circuit when the DTE has received a request to establish a frame relay switched virtual circuit but has not yet responded.
- **Incoming Call Proceeding (U9)** – This state exists for an incoming call when the DTE has acknowledged the receipt of the request to establish a frame relay switched virtual circuit.
- **Active (U10)** – This state exists for an incoming or outgoing switched virtual circuit when the frame relay switched virtual circuit has been established and data transfer phase can begin.
- **Disconnect Request (U11)** – This state exists when the DTE has requested the DCE to disconnect the frame relay switched virtual circuit and is waiting for a response.
- **Disconnect Indication (U12)** – This state exists when the DTE has received an invitation to disconnect the frame relay switched virtual circuit and has not replied yet.
- **Release request (U19)** – This state exists when the DTE has sent a request to the DCE to release the frame relay switched virtual circuit and is waiting for the response.

10.4.2 Call states at the DCE side

The following states are the DCE states that may exist at the DCE side of the DTE/DCE interface, (the states have local significance):

- **Null (N0)** – No switched virtual circuit exists.
- **Call Initiated (N1)** – This state exists for an outgoing switched virtual circuit when the DCE has received a request to establish a frame relay switched virtual circuit but has not yet responded.
- **Outgoing Call Proceeding (N3)** – This state exists for an outgoing switched virtual circuit when the DCE has acknowledged the receipt of the information necessary to establish the frame relay switched virtual circuit.
- **Call Present (N6)** – This state exists for an incoming switched virtual circuit when the DCE has sent a request to establish a frame relay switched virtual circuit but the DTE has not responded.
- **Incoming Call Proceeding (N9)** – This state exists for an incoming switched virtual circuit when the DCE has received an acknowledgement that the called DTE has received the request to set up the frame relay switched virtual circuit.
- **Active (N10)** – This state exists for an incoming or outgoing switched virtual circuit when the frame relay connection has been established and the data transfer phase can begin.
- **Disconnect Request (N11)** – This state exists when the DCE has received a request from the DTE to disconnect the frame relay switched virtual circuit.
- **Disconnect Indication (N12)** – This state exists when the DCE has disconnected the frame relay switched virtual circuit and has sent an invitation to disconnect and is waiting for the reply from the DTE.
- **Release Request (N19)** – This state exists when the DCE has requested the DTE to release the frame relay switched virtual circuit and is waiting for the response.

10.4.3 States used with the restart facility

The following states are associated with the restart facility, the states are the states of the DTE or DCE side of the interface and have a local significance:

- **Null (Rest0)** – No restart request exists.
- **Restart request (Rest1)** – This state exists after a DTE or a DCE has sent a restart request to the other side of the DTE/DCE interface and is waiting for an acknowledgement.
- **Restart (Rest2)** – This state exists when one side of the DTE/DCE interface has received a request for a restart and has not returned an acknowledgement yet.

10.5 Message definitions

This clause provides an overview of the message structure, which highlights the functional definition and information content of each message. Each definition includes:

- 1) A brief description of the message direction and use, including whether the message has:
 - a) Local significance, i.e., relevant only at a DTE/DCE interface;
 - b) Global significance, i.e., relevant at both the local and remote DTE/DCE interfaces and in the network.
- 2) A table listing the information elements in the order of their appearance in the message. For each information element the table indicates:
 - a) the clause of this Recommendation describing the information element;
 - b) the direction in which it may be sent, i.e., DTE to DCE, DCE to DTE or both;

- c) 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;
- d) the length of the information element (or permissible range of length) in octets. "*" denotes an undefined length which may be network or DTE/DCE dependent;
- e) further explanatory notes as necessary.

Table 10-1 lists the messages for frame relay SVC. These messages are a subset of the messages defined and specified in ITU-T Recs Q.931 and Q.933.

Every message transferred across the DTE/DCE interface on the logical data link identified by DLCI = 0 consists of at least five octets. These five octets contain a Protocol Discriminator (1 octet), a Call Reference (3 octets) and a Message Type (1 octet). Other information elements are included as required.

Table 10-1/X.36 – Messages for frame relay SVC signalling

Message	Reference
<i>Virtual circuit establishment messages:</i>	
CALL PROCEEDING	10.5.1
CONNECT	10.5.2
SETUP	10.5.8
<i>Virtual circuit clearing messages:</i>	
DISCONNECT	10.5.3
RELEASE	10.5.4
RELEASE COMPLETE	10.5.5
<i>Miscellaneous messages:</i>	
RESTART	10.5.6
RESTART ACKNOWLEDGE	10.5.7
STATUS	10.5.9
STATUS ENQUIRY	10.5.10

10.5.1 CALL PROCEEDING

This message is sent by the DCE to the calling DTE and by the called DTE to the DCE to indicate that the set-up request for the switched virtual connection has been initiated. This message acknowledges the receipt of the SETUP message, (see Table 10-2).

Table 10-2/X.36 – CALL PROCEEDING message content

Message type: CALL PROCEEDING		Direction: Both		
Significance: Local				
Information element	Reference	Direction	Type	Length
Protocol discriminator	10.6.1	Both	Mandatory	1
Call reference	10.6.2	Both	Mandatory	3
Message type	10.6.3	Both	Mandatory	1
Data Link Connection Identifier	10.6.14	Both	Mandatory	4-6

10.5.2 CONNECT

This message is sent by the called DTE to the DCE and by the DCE to the calling DTE to indicate that the called DTE has accepted the request to establish a switched virtual circuit (see Table 10-3).

Table 10-3/X.36 – CONNECT message content

Message type: CONNECT Significance: Global		Direction: Both		
Information element	Reference	Direction	Type	Length
Protocol discriminator	10.6.1	Both	Mandatory	1
Call reference	10.6.2	Both	Mandatory	3
Message type	10.6.3	Both	Mandatory	1
Data Link Connection Identifier	10.6.14	Both	Optional (Note 1)	4-6
Link layer core parameters	10.6.15	Both	Mandatory	4-31
Connected number	10.6.12	Both	Optional (Note 2)	*
Connected subaddress	10.6.13	Both	Optional (Note 3)	*
Low layer compatibility	10.6.17	Both	Optional (Note 5)	4-15
User-user	10.6.21	Both	Optional (Note 4)	2-131
NOTE 1 – Mandatory in the DTE-to-DCE direction when the called DTE replies to the incoming SETUP message with a CONNECT message. In all other cases it is optional. NOTE 2 – If included by the called DTE in the DTE-to-DCE direction, then its presence is optional in the DCE-to-DTE direction if it is the same as the Called party number presented to the called DTE in the SETUP message. Its presence is mandatory in the DCE-to-DTE direction if it is different from the called party number presented to the called DTE in the SETUP message. NOTE 3 – Included in the DCE-to-DTE direction at the calling DTE/DCE interface if it was included in the DTE-to-DCE direction at the called DTE/DCE interface to identify the connected subaddress to the calling DTE. NOTE 4 – Included in the DCE-to-DTE direction at the calling DTE/DCE interface if it was included in the DTE-to-DCE direction at the called DTE/DCE interface to pass user data from the answering DTE to the calling DTE. NOTE 5 – Included in the DCE-to-DTE direction at the calling DTE/DCE interface if it was included in the DTE-to-DCE direction at the called DTE/DCE interface. See procedures in D.6.				

10.5.3 DISCONNECT

This message is sent by a DTE to the DCE, and by a DCE to a DTE to disconnect the frame relay SVC (see Table 10-4).

Table 10-4 /X.36 – DISCONNECT message content

Message type: DISCONNECT		Direction: Both		
Significance: Global				
Information element	Reference	Direction	Type	Length
Protocol discriminator	10.6.1	Both	Mandatory	1
Call reference	10.6.2	Both	Mandatory	3
Message type	10.6.3	Both	Mandatory	1
Cause	10.6.10	Both	Mandatory	4-*

10.5.4 RELEASE

This message is sent by a DTE to the DCE, and by the DCE to the DTE to clear the frame relay SVC (see Table 10-5).

Table 10-5/X.36 – RELEASE message content

Message type: RELEASE		Direction: Both		
Significance: Local (Note 1)				
Information element	Reference	Direction	Type	Length
Protocol discriminator	10.6.1	Both	Mandatory	1
Call reference	10.6.2	Both	Mandatory	3
Message type	10.6.3	Both	Mandatory	1
Cause	10.6.10	Both	(Note 2)	4-*
NOTE 1 – This message has local significance. However, it may carry information of global significance when used as the first call clearing message.				
NOTE 2 – Mandatory if the RELEASE message is the first call clearing message sent as a result of an error handling condition; otherwise, it is optional. This information element may be repeated to indicate multiple clearing causes.				

10.5.5 RELEASE COMPLETE

This message is sent by a DTE to the DCE and by the DCE to the other DTE as part of the clearing process (see Table 10-6).

Table 10-6/X.36 – RELEASE COMPLETE message content

Message type: RELEASE COMPLETE		Direction: Both		
Significance: Local (Note 1)				
Information element	Reference	Direction	Type	Length
Protocol discriminator	10.6.1	Both	Mandatory	1
Call reference	10.6.2	Both	Mandatory	3
Message type	10.6.3	Both	Mandatory	1
Cause	10.6.10	Both	(Note 2)	4-*
NOTE 1 – This message has local significance. However, it may carry information of global significance when used as the first call clearing message.				
NOTE 2 – Mandatory if the RELEASE COMPLETE message is the first call clearing message sent as a result of an error handling condition, otherwise it is optional. This information element may be repeated to indicate multiple clearing causes.				

10.5.6 RESTART

This message is sent by a DTE to a DCE or a DCE to a DTE to request the recipient to restart (i.e., return to an idle condition) the DTE/DCE interface (see Table 10-7).

Table 10-7/X.36 – RESTART message content

Message type: RESTART Significance: Local		Direction: Both		
Information element	Reference	Direction	Type	Length
Protocol discriminator	10.6.1	Both	Mandatory	1
Call reference	10.6.2	Both	Mandatory (Note)	3
Message type	10.6.3	Both	Mandatory	1
NOTE – The RESTART message is sent with the global call reference.				

10.5.7 RESTART ACKNOWLEDGE

This message is sent by a DTE to a DCE or a DCE to a DTE to acknowledge the receipt of the restart message and to indicate that the requested restart is complete (see Table 10-8).

Table 10-8/X.36 – RESTART ACKNOWLEDGE message content

Message type: RESTART ACKNOWLEDGE Significance: Local		Direction: Both		
Information element	Reference	Direction	Type	Length
Protocol discriminator	10.6.1	Both	Mandatory	1
Call reference	10.6.2	Both	Mandatory (Note)	3
Message type	10.6.3	Both	Mandatory	1
NOTE – The RESTART ACKNOWLEDGE message is sent with the global call reference.				

10.5.8 SETUP

This message is sent by the calling DTE to the DCE, and by the DCE to the called DTE to initiate the establishment of the Frame Relay switched virtual circuit (see Table 10-9).

Table 10-9/X.36 – SETUP message content

Message type: SETUP Significance: Global		Direction: Both		
Information element	Reference	Direction	Type	Length
Protocol discriminator	10.6.1	Both	Mandatory	1
Call reference	10.6.2	Both	Mandatory	3
Message type	10.6.3	Both	Mandatory	1
Bearer capability	10.6.4	Both	Mandatory	5
Data Link Connection Identifier	10.6.14	n → u	Mandatory (Note 1)	4-6
Closed user group	10.6.11	Both	Optional	4-7
Link layer core parameters	10.6.15	Both	Optional (Note 2)	4-31
Link layer protocol parameters	10.6.16	Both	Optional	2-9
Priority and service class parameters	10.6.18	Both	Optional	2-8
Reverse charging indication	10.6.19	Both	Optional	3
Calling party number	10.6.8	Both	Optional (Note 3)	*
Calling party subaddress	10.6.9	Both	Optional (Note 4)	*
Called party number	10.6.6	Both	Optional (Note 5)	*
Called party subaddress	10.6.9	Both	Optional (Note 6)	*
Transit network selection	10.6.20	u → n	Optional	7-11
Low layer compatibility	10.6.17	Both	Optional (Notes 6, 7, 8)	4-15
User-user	10.6.21	Both	Optional (Note 6)	2-131

Table 10-9/X.36 – SETUP message content

NOTE 1 – Mandatory in the DCE-to-DTE direction. Not allowed in the DTE-to-DCE direction.

NOTE 2 – Included in the DTE-to-DCE direction when the calling DTE wants to indicate the proposed link layer core parameters to the network. Always included in the DCE-to-DTE direction. If the link layer core parameters information element is missing or partially specified, in the DTE-to-DCE direction, the network will use default values and will present them to the called DTE.

NOTE 3 – Mandatory in the DCE-to-DTE direction to identify the calling user. Optional in the DTE-to-DCE direction.

NOTE 4 – Included in the DCE-to-DTE direction if the calling party included this information element in the DTE-to-DCE direction.

NOTE 5 – Mandatory in the DTE-to-DCE direction to identify the called user. Included in the DCE-to-DTE direction when called party number information is to be conveyed to the called DTE (e.g., when the called DTE is a private network).

NOTE 6 – Included in the DCE-to-DTE direction at the called DTE/DCE interface if it was included by the calling DTE.

NOTE 7 – Included in the DCE-to-DTE direction at the called DTE/DCE interface if it was included by the calling DTE. This information element may be repeated according to the procedures in D.6.

NOTE 8 – This information element may occur up to three times.

10.5.9 STATUS

This message is sent by the DCE to a DTE and by a DTE to the DCE in response to a STATUS ENQUIRY or at any time to report certain error condition (see Table 10-10).

Table 10-10/X.36 – STATUS message content

Message type: STATUS Significance: Local		Direction: Both		
Information element	Reference	Direction	Type	Length
Protocol discriminator	10.6.1	Both	Mandatory	1
Call reference	10.6.2	Both	Mandatory	3
Message type	10.6.3	Both	Mandatory	1
Cause	10.6.10	Both	Mandatory	4-*
Call State	10.6.5	Both	Mandatory	3

10.5.10 STATUS ENQUIRY

This message is sent by a DTE to the DCE and by the DCE to a DTE at any time to solicit a STATUS message (see Table 10-11).

Table 10-11/X.36 – STATUS ENQUIRY message content

Message type: STATUS ENQUIRY Significance: Local		Direction: Both		
Information element	Reference	Direction	Type	Length
Protocol discriminator	10.6.1	Both	Mandatory	1
Call reference	10.6.2	Both	Mandatory	3
Message type	10.6.3	Both	Mandatory	1

10.6 General message format and information element coding

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

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

- a) Protocol discriminator;
- b) Call reference;
- c) Message type;
- d) 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 10-2.

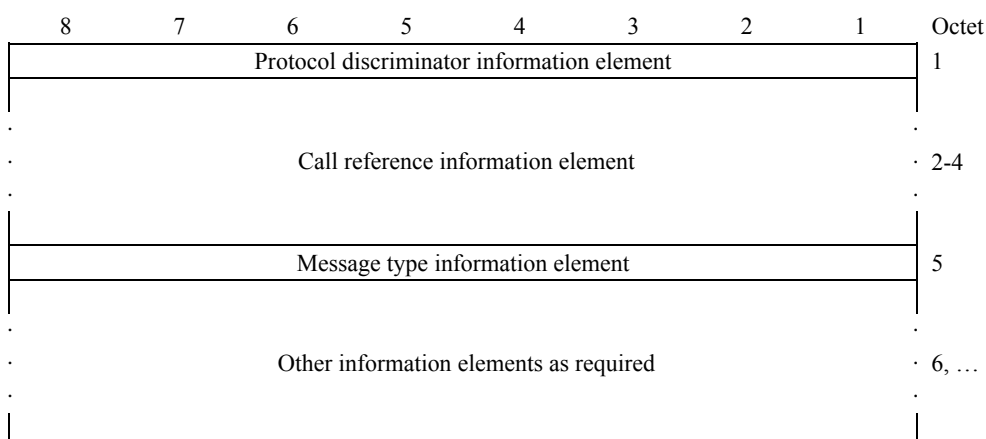


Figure 10-2/X.36 – General message organization example

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

The information elements used for frame relay SVC are:

Information element	Information element identifier	Reference
Protocol discriminator	Not applicable	10.6.1
Call reference	Not applicable	10.6.2
Message type	Not applicable	10.6.3
Bearer Capability	0 0 0 0 0 1 0 0	10.6.4
Call State	0 0 0 1 0 1 0 0	10.6.5
Called party number	0 1 1 1 0 0 0 0	10.6.6
Called party subaddress	0 1 1 1 0 0 0 1	10.6.7
Calling party number	0 1 1 0 1 1 0 0	10.6.8
Calling party subaddress	0 1 1 0 1 1 0 1	10.6.9
Cause	0 0 0 0 1 0 0 0	10.6.10
Closed user group	0 1 0 0 0 1 1 1	10.6.11
Connected number	0 1 0 0 1 1 0 0	10.6.12

Information element	Information element identifier	Reference
Connected subaddress	0 1 0 0 1 1 0 1	10.6.13
Data link connection identifier	0 0 0 1 1 0 0 1	10.6.14
Link layer core parameters	0 1 0 0 1 0 0 0	10.6.15
Link layer protocol parameters	0 1 0 0 1 0 0 1	10.6.16
Low layer compatibility	0 1 1 1 1 1 0 0	10.6.17
Priority and service class parameters	0 1 1 0 1 0 1 0	10.6.18
Reverse charge indication	0 1 0 0 1 0 1 0	10.6.19
Transit network selection	0 1 1 1 1 0 0 0	10.6.20
User-user	0 1 1 1 1 1 1 0	10.6.21

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 future 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".
- 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, ... 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.
- 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.

10.6.1 Protocol discriminator

The protocol discriminator is the first part (first octet) of every message. It is coded as shown in Figure 10-3.

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

Figure 10-3/X.36 – Protocol discriminator

10.6.2 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 10-4. 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.

8	7	6	5	4	3	2	1	Octet
0	0	0	0	Length of call reference (in octets)				1
Flag	Call reference value (most significant 7 bits)							2
Call reference value (2nd most significant 8 bits)								3

Flag (octet 2)

Bit

8

- 0 The message is sent **from** the side of the DTE/DCE interface that originates the call reference.
- 1 The message is sent **to** the side of the DTE/DCE interface that originates the call reference.

Figure 10-4/X.36 – Call reference information element

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 DTE/DCE interface 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.

10.6.3 Message type

The purpose of the message type is to identify the message being sent. The message type is the third part of every message (see Figure 10-5 and Table 10-12).

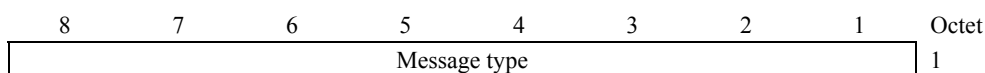


Figure 10-5/X.36 – Message type

Table 10-12/X.36 – Message types

Bits	
<u>8 7 6 5 4 3 2 1</u>	
0 0 0 0 0 1 0	<i>SVC establishment messages</i>
0 0 0 0 0 1 1	CALL PROCEEDING
0 0 0 0 0 1 0 1	CONNECT
	SETUP
	<i>SVC clearing messages</i>
0 1 0 0 0 1 0 1	DISCONNECT
0 1 0 0 1 1 0 1	RELEASE
0 1 0 1 1 0 1 0	RELEASE COMPLETE
	<i>Miscellaneous messages</i>
0 1 0 0 0 1 1 0	RESTART
0 1 0 0 1 1 1 0	RESTART ACKNOWLEDGE
0 1 1 1 1 1 0 1	STATUS
0 1 1 1 0 1 0 1	STATUS ENQUIRY

10.6.4 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 10-6.

8	7	6	5	4	3	2	1	Octet (Note)
Bearer capability information element 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 group 5 defined in ITU-T Recs Q.931 and Q.933 is not used. For consistency, Q.931 and Q.933 octet numbering is kept.

Figure 10-6/X.36 – Bearer capability information element

10.6.5 Call state

The purpose of the Call state information element is to describe the current state of a frame relay connection. The Call state information element is coded as shown in Figure 10-7 and Table 10-13.

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
0	0	0	0	0	0	0	1	
Coding Standard		Call state value/Global interface state (state value is coded in binary)						3
0	0							

Figure 10-7/X.36 – Call state information element

Table 10-13/X.36 – Call state information element

<i>Call state value (octet 3)</i>			
Bits			
<u>6 5 4</u>	<u>3 2 1</u>	<i>Call state at the DTE side</i>	<i>Call state at the DCE side</i>
0 0 0	0 0 0	U0 Null	N0 Null
0 0 0	0 0 1	U1 Call initiated	N1 Call initiated
0 0 0	0 1 1	U3 Outgoing call proceeding	N3 Outgoing call proceeding
0 0 0	1 1 0	U6 Call present	N6 Call present
0 0 1	0 0 1	U9 Incoming call proceeding	N9 Incoming call proceeding
0 0 1	0 1 0	U10 Active	N10 Active
0 0 1	0 1 1	U11 Disconnect request	N11 Disconnect request
0 0 1	1 0 0	U12 Disconnect indication	N12 Disconnect indication
0 1 0	0 1 1	U19 Release request	N19 Release request
<i>Global interface state value (octet 3)</i>			
Bits			
<u>6 5 4</u>	<u>3 2 1</u>	<i>State</i>	
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	
All other values are reserved.			

10.6.6 Called party number

The purpose of the Called party number information element is to identify the called party of a call. The Called party number information element is coded as shown in Figure 10-8 and Table 10-14.

8	7	6	5	4	3	2	1	Octet
Called party number information element identifier								1
0	1	1	1	0	0	0	0	
Length of called party number contents								2
ext. 1	Type of number			Numbering plan identification				3
0	Number digits (coded according to ITU-T Rec. T.50)							4
								etc.

Figure 10-8/X.36 – Called party number information element

Table 10-14/X.36 – Called party number information element

Type of number (octet 3)

Bits

7 6 5

- 0 0 1 International number (Note 1)
- 0 1 0 National number (Note 1)
- 0 1 1 Network specific number (for use in private network)
- 1 0 0 Complementary address without main address/subscriber number (Note 2)
- 1 0 1 Alternative address (see Numbering plan identification)
- 1 1 1 Reserved for extensions

All other values are reserved.

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

NOTE 2 – The use of this code point is a network option (see Appendix IV).

Numbering plan identification (octet 3)

Bits

4 3 2 1

- 0 0 0 0 Unknown
- 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)
- 1 0 0 1 Private numbering plan (for use with private networks)

All other values are reserved.

Numbering plan identification coding (octet 3) when type of number is alternative address

Bits

4 3 2 1

- 0 0 0 0 Character string coded in accordance with ITU-T Rec. T.50 and ISO/IEC 646. (Note 3)
- 0 0 0 1 ISO NSAP address coded in accordance with ITU-T Rec. X.213 | ISO/IEC 8348.
- 0 0 1 0 Media Access Control (MAC) address coded in accordance with ISO/IEC 10039. (Note 3)
- 0 0 1 1 Internet address coded in accordance with RFC 1166. (Note 3)

All other values are reserved.

NOTE 3 – The use of this code point is *for further study*.

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 corresponds to a T.50 character.

Valid combinations of type of number and numbering plan fields

Type of numbering	Numbering plan identification	Format
International	E.164	CC + N(S)N
International	X.121	DNIC + NTN
National	E.164	N(S)N
National	X.121	NTN or NN
Network specific	Private numbering plan	According to the private numbering plan
Alternative address	ISO NSAP	Number/address following NSAP format (Note 4)
Complementary address without main address	Unknown	User-specific

Table 10-14/X.36 – Called party number information element

NOTE 4 – This combination is used to allow the coding of an NSAP. The support of this combination is a network option. 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 NSAP. It rather allows the selection of a route towards a frame relay/ATM interworking unit.

10.6.7 Called party subaddress

The purpose of the Called party subaddress information element is to identify the subaddress of the called party of the call. The network does not interpret this information element. It is carried transparently between the calling and called interface. The Called party subaddress information element is coded as shown in Figure 10-9 and Table 10-15.

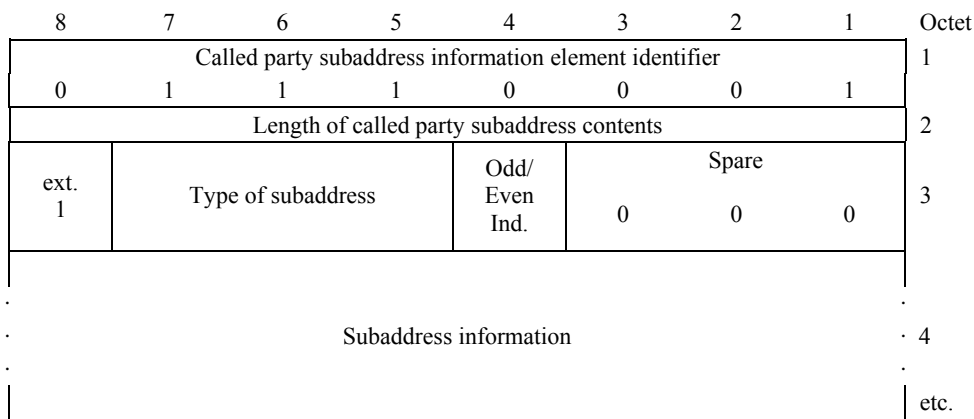


Figure 10-9/X.36 – Called party subaddress information element

Table 10-15/X.36 – Called party subaddress information element

Type of subaddress (octet 3)

Bits

7 6 5

0 0 0 NSAP (ITU-T Rec. X.213 | ISO/IEC 8348)

0 1 0 User specified

All other values are reserved.

Odd/even indicator (octet 3)

Bit

4

0 Even number of subaddress digits

1 Odd number of subaddress digits

NOTE – The odd/even indicator is used when the type of subaddress (octet 3) is user specified and the coding is BCD.

Subaddress information (octet 4, etc.)

The subaddress information is formatted according to the coding of the type of subaddress field (octet 3).

10.6.8 Calling party number

The purpose of the Calling party number information element is to identify the origin of a frame relay switched virtual circuit. The Calling party number information element is coded as shown in Figure 10-10 and Table 10-16.

8	7	6	5	4	3	2	1	Octet
0	Calling party number information element identifier							1
	1	1	0	1	1	0	0	
Length of calling party number contents								2
ext. 0/1	Type of number			Numbering plan identification				3
ext. 1	Presentation indicator		Spare 0 0 0			Screening indicator		3a*
0	Number digits (coded according to ITU-T Rec. T.50)							4
								etc.

Figure 10-10/X.36 – Calling party number information element

Table 10-16/X.36 – Calling party number information element

<i>Type of number (octet 3)</i>	
Bits	
<u>7 6 5</u>	
0 0 1	International number (Note 1)
0 1 0	National number (Note 1)
0 1 1	Network specific number (for use in private network)
1 0 0	Complementary address without main address/subscriber number (Note 2)
1 0 1	Alternative address (See Numbering plan identification)
1 1 1	Reserved for extensions
All other values are reserved.	
NOTE 1 – Prefix or escape digits shall not be included in the number digits.	
NOTE 2 – The use of this code point is a network option (see Appendix IV).	
<i>Numbering plan identification (octet 3)</i>	
Bits	
<u>4 3 2 1</u>	
0 0 0 0	Unknown
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)
1 0 0 1	Private numbering plan (Note 3)
All other values are reserved.	
NOTE 3 – For use with private networks.	
<i>Numbering plan identification coding (octet 3) when type of address is alternative address</i>	
Bits	
<u>4 3 2 1</u>	
0 0 0 0	Character string coded in accordance with ITU-T Rec. T.50 and ISO/IEC 646. (Note 4)
0 0 0 1	ISO NSAP address coded in accordance ITU-T Rec. X.213 ISO/IEC 8348.
0 0 1 0	Media Access Control (MAC) address coded in accordance with ISO/IEC 10039. (Note 4)
0 0 1 1	Internet address coded in accordance with RFC 1166. (Note 4)
All other values are reserved.	
NOTE 4 – The use of this code point is for further study.	