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# CCITT

**I.233**

THE INTERNATIONAL
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CONSULTATIVE COMMITTEE

**INTEGRATED SERVICES DIGITAL NETWORK (ISDN)**

**GENERAL STRUCTURE AND SERVICE CAPABILITIES**

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# FRAME MODE BEARER SERVICES

**Recommendation I.233**

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Geneva, 1992

## FOREWORD

The CCITT (the International Telegraph and Telephone Consultative Committee) is a permanent organ of the International Telecommunication Union (ITU). CCITT is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The Plenary Assembly of CCITT which meets every four years, establishes the topics for study and approves Recommendations prepared by its Study Groups. The approval of Recommendations by the members of CCITT between Plenary Assemblies is covered by the procedure laid down in CCITT Resolution No. 2 (Melbourne, 1988).

Recommendation I.233 was prepared by Study Group XVIII and was approved under the Resolution No. 2 procedure on the 25th of October 1991.

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CCITT NOTES

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

2) A list of abbreviations used in this Recommendation can be found in Annex E and C.

**Recommendation I.233**

## FRAME MODE BEARER SERVICES

Recommendation I.210 describes the principles for defining telecommunication services supported by an ISDN including the concept of bearer services, teleservices and supplementary services. It also provides the means for the definition and description of such services. A recommended set of bearer service categories is defined in Recommendation I.230.

The purpose of this Recommendation is to describe a recommended set of frame mode bearer services (FMBS), to describe individual frame mode bearer services and to recommend their provision in an ISDN.

Bearer services are described by prose definitions and descriptions, by attributes and their values and by dynamic descriptions following the description method given in Recommendation I.130. The application of the attribute technique and the definition of those attributes and attribute values is given in Recommendation I.140.

The following set of frame mode bearer services is currently identified:

I.233.1 ISDN frame relay in bearer service

I.233.2 ISDN frame switching bearer service.

## ISDN FRAME RELAYING BEARER SERVICE

## 1 Introduction

Recommendation I.210 describes the principles for defining telecommunication services supported by an ISDN including the concept of bearer services, teleservices and supplementary services. It also provides the means for the definition and description of such services. The purpose of this Recommendation is to describe the frame relaying bearer service and to recommend the method of its provision in an ISDN. The definition and description of this service form the basis to define the network capabilities required for the support of the service in an ISDN. According to Recommendation I.210 a stage 1 service description uses three steps: prose description, static description and dynamic description. These steps begin in §§ 1, 8 and 9 respectively.

## 2 Definition

The frame relaying bearer service provides the bidirectional transfer of service data units (SDU) from one S or T reference point to another with the order preserved. The service data units are routed through the network by appropriate layer 2 PDUs on the basis of an attached label. This label is a logical identifier with local significance [termed DLCI (data link connection identifier) in the protocol description].

The user network interface structure at the S or T reference point allows for the establishment of multiple virtual calls and/or permanent virtual circuits to many destinations. This service is generally available on the following ISDN access arrangements: point-to-multipoint (passive bus) and point-to-point (NT2).

It is a requirement of this service description to show how the OSI network layer service could be supported.

## 3 Description

### 3.1 *General description*

The frame relaying bearer service has the following characteristics:

1) All C-plane procedures, if needed, are performed in a logically separate manner using protocol procedures that are integrated across all ISDN telecommunication services.

2) The U-plane procedures at layer 1 are based on Recommendations I.430/I.431. Layer 2 procedures are based on the core functions of Recommendation Q.922 (see § 3.1.1). These layer 2 core functions allow for the statistical multiplexing of user information flows immediately above layer 1 functions. This bearer service provides the bidirectional transfer of service data units (frames) from one S or T reference point to another with the order preserved.

This bearer service:

1) preserves the order of SDUs transmitted at one S or T reference point when they are delivered at the other end;

   *Note* – Since the network does not support any procedure above the core functions of Recommendation Q.922, sequence numbers are not kept by the network. Networks should be implemented in such a way that, in principle, frame order is preserved.

2) detects transmission, format and operational errors (e.g. frames with unknown label);

3) transports frames transparently, only the label and frame check sequence (FCS) may be modified by the network;

4) does not acknowledge frames (within the network).

The functions above are based on the core functions of Recommendation Q.922. It provides service quality that is characterized by the values of the following parameters:

1) throughput;

2) access rate;

3) committed information rate;

4) committed burst size;

5) excess burst size;

6) transit delay;

7) residual error rate;

8) delivered errored frames;

9) delivered duplicated frames;

10) delivered out-of-sequence frames;

11) lost frames;

12) misdelivered frames.

3.1.1 *Core functions*

The core functions of Recommendation Q.922 are:

– frame delimiting, alignment and transparency;

– frame multiplexing/demultiplexing using the address field[1];

– inspection of the frame to ensure that it consists of an integer 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 (see § 4.2.2.1.6);

– detection of transmission errors;

– congestion control functions.

3.2 *Specific terminology*

See Annex A.

3.3 *Qualifications*

Not applicable

3.4 *Applications*

The frame mode bearer service described in this Recommendation aims to support a wide range of data applications and rates from very low to high (typically 2 Mbit/s). A typical application may be interconnection between local area networks (LANs).

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[1] The address field default length is 2 octets. It can be extended to 3 or 4 octets where the final octet is optionally a control information field.

## 4 Procedures

### 4.1 *Provision/withdrawal*

This bearer service is offered with several subscription options which apply separately to each ISDN number or group of ISDN numbers on the interface. For each subscription option, only one value can be selected. Subscription options for the interface are summarized below:

- general subscription to the frame relaying bearer service[2), 3)];
- subscription to the frame relaying bearer service with user defined profile;
- subscription to the conveyance of sub-addresses for terminal selection and/or conveyance of NSAP addresses for support of the OSI network layer service[4)];
- subscription to the Multiple Subscriber Number (MSN) or Direct-Dialling-In (DDI) supplementary services may be required for terminal selection purposes.

In general, there will be a limit on the number of information channels available at the user-network interface:

- maximum number of total calls present (active frame relayed VCs) per interface = N;
- maximum number of total calls present (active frame relayed VCs) per channel (D, B, H) = M.

### 4.2 *Normal procedures*

All user-network signalling takes place using logically separate messages.

On the user side of the S or T reference point, Recommendation I.430 or I.431 provides the layer 1 protocol for the U (user) and C (control) planes. The C-plane uses the D-channel with Recommendations Q.921 and Q.933 as the layer 2 and 3 protocols respectively. For permanent virtual circuits (PVCs), no real-time call establishment is necessary and any parameters are agreed upon at subscription time. The U-plane may use any channel (D, B or H) on which the user implements the core functions of Recommendation Q.922.

#### 4.2.1 *Activation/deactivation/registration*

Not applicable.

#### 4.2.2 *Invocation and operation*

Virtual call and permanent virtual circuit procedures can be invoked and operated concurrently by a given terminal.

##### 4.2.2.1 *Virtual call procedures*

Before procedures for originating the service are invoked, a layer 1 physical channel and a reliable data link connection for signalling are required.

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2) Some networks may not require specific subscription of the frame relaying bearer service since it may be offered as a default for general ISDN subscription.

3) The address convention (e.g. address length) is agreed at subscription time. A single address convention applies per access.

4) The conveyance of NSAP addresses may be restricted if the Calling Line Identification Restriction (CLIR) or Connected Line Identification Restriction (COLR) are used.

4.2.2.1.1 *Originating the service (call set-up)*

The call is originated by the user requesting from the network the required bearer service, with this request including a number identifying the called user. Other information required for the bearer service and additional information (e.g. calling line identity) may also be included.

There are three possible channel types (D, B, H) that could be used. Moreover, there are two possible physical channel access arrangements:

– demand establishment of the channel;

– semi-permanent establishment of the channel.

In the first arrangement, if a physical channel is not established, or already established channels have no free capacity, another channel (if available) is established using Q.933 procedures.

In the second arrangement and also for the D-channel, no dynamic establishment procedure is required.

Once a physical channel has been established either dynamically or semi-permanently then, in the virtual call case, the value of the logical identifier and the other associated parameters, as defined in § 1, are negotiated during the call set-up by means of C-plane procedures. Depending on the parameters requested, the network may accept or reject the call.

The user network interface structure at the S or T reference point allows for the establishment of multiple virtual calls and/or permanent virtual circuits to one or more destination(s).

Since it is a requirement of this service description to show how the OSI network layer service could be supported, Recommendation Q.933 will be used to carry the connection establishment and release primitives and parameters for the OSI network service. See Annex B for details.

4.2.2.1.2 *Indications during call set-up*

If interworking takes place, an indication of such interworking is required. The user can then decide whether to proceed with the interworking or to clear the call. See § 6 and I.500-Series Recommendations.

See also Annex B for indications specific to the support of the OSI network service.

4.2.2.1.3 *Terminal selection/identification*

The Multiple Subscriber Number and Direct-Dialling-In supplementary services as well as sub-addressing are methods applicable to terminal selection and identification.

4.2.2.1.4 *Call notification*

Q.933 procedures are used to notify the user of incoming calls.

*Note* – Channel negotiation allows the called user to request that a call be offered on a specific channel, D, B or H.

4.2.2.1.5 *Synchronization between C-plane and U-plane*

In some cases there is a gap between the time a connect confirmation is received and when the actual connection is established. It may be necessary to verify the connection prior to the beginning of data transfer. This should be accomplished end-to-end in the U-plane.

4.2.2.1.6 Virtual call procedures data transfer

Frame relaying data units are frames as defined in Recommendation Q.922. The basic bearer service provided by the network is the unacknowledged transfer of frames between S or T reference points.

The frame size supported by this service is determined by the following factors:

a) the default maximum information field to be supported by all networks is 260 octets;

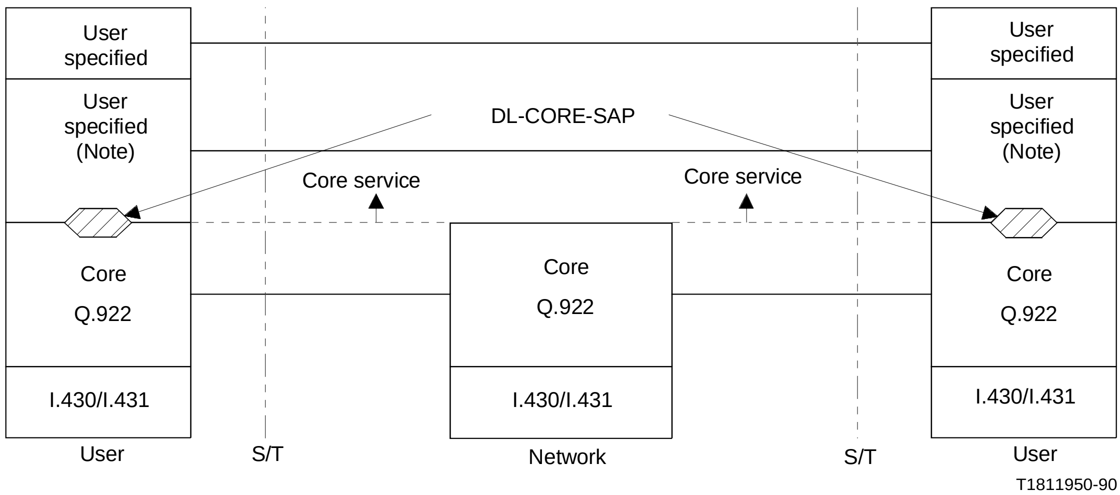
b) all other values are negotiated between users and networks and between networks;

c) the support by networks of a negotiated value of at least 1600 octets is strongly recommended for applications such as LAN (ISO 8802-3) interconnect, to prevent the need for segmentation and reassembly by the user equipment;

d) when interworking with frame switching, and the D-channel is used, the maximum information field that can be used is 260 octets (N201).

In particular, the frame relay default of 262 octets (N202) cannot be used without negotiation when interconnected with a frame switching network due to the two byte frame switching control field. In this case, without negotiation, the frame relay user must use the N201 (260 octet) value.

Figure 1/I.233.1 illustrates the U-plane configuration for this service. Protocol functions up to and including layer 3 are shown. The network does not terminate the full layer 2 (Q.922) protocol. The bearer service provided at the user-network interface (S or T reference point) included in a sub-layer, supports only the core functions as defined in § 3.1.1. This sub-layer provides a core service which is modelled in a formal way in Annex C. The sub-layer provides the delimited and unacknowledged transparent transmission of protocol data units containing a number of octets up to the maximum information field size as defined above. The protocol service data units are transmitted in frames. A frame received by a sub-layer entity is discarded if the frame does not meet the Q.922 core requirements. Also, frames may be discarded by the network due to internal network conditions, or other reasons such as throughput enforcement. In all other cases the frame is relayed to the end user.




*Note* – Q.922 is one protocol which may be used. Other standard or proprietary protocols may be used.

FIGURE 1/I.233.1

**U-plane configuration**

The core service can be offered on both basic and primary rate interfaces and on any ISDN channel (D, B and H). Some restrictions, e.g. frame size, apply when in an end-to-end connection at least one of the access channels is the D (16/64 kbit/s) channel.

The data transfer phase of the OSI connection oriented network layer service (CONS/Recommendation X.213) can be provided by using X.25 DTP, appropriate ISO layer 2/3 protocols or a convergence protocol above Q.922. In the latter case only the mandatory[5)] features of the network service as defined in Recommendation X.213 are provided. Even though all these arrangements are permitted, the combination of Q.922 and X.25 DTP protocols is preferred because it allows for easy interworking with the frame switching bearer service and networks using Recommendation X.25. See Annex B for details.

The core service provided in the U-plane can be used to provide the OSI connectionless network service (ISO 8348 ADD 1) by using ISO 8473 or other OSI connectionless network protocols directly above the core service or, for example, above the Q.922 unacknowledged information transfer service. In this case it is assumed that a permanent link is used. The use of on-demand links is for further study.

4.2.2.1.7 *Congestion management and control*

Congestion in the U-plane of a frame relay bearer service occurs when traffic, arriving at a resource (e.g. memory, bandwidth, processor), exceeds the network engineered level. It can also occur for other reasons (e.g. equipment failure). The impact of network congestion is performance degradation in terms of throughput and delay.

The primary objectives of congestion control mechanisms are to maintain, with very high probability, specified quality of service (e.g. throughput, delay, frame loss) for each virtual call or permanent virtual circuit. Recommendation I.370 deals with this in detail.

4.2.2.1.8 *Terminating the service (call clearing)*

When the call is cleared all resources used by the call are cleared (e.g. label, call reference value, etc.). In the demand channel establishment arrangement, if no calls are present and if the user or network desires, either the user or the network may clear the physical channel.

If the network desires it may deactivate the C-plane layer 2 and interface layer 1.

*Note* – Primary rate access (PRA) has no defined deactivated state.

In the semi-permanent channel access arrangement, the network or user may only deactivate the C-plane layer 2.

The frame relayed virtual call may be terminated by either or both of the users by indicating this to the network. In either case, an appropriate indication is sent to the other user. The network may terminate the call for several reasons, for example, severe congestion, error or failure conditions.

4.2.2.2 *Permanent virtual circuit procedures*

For permanent virtual circuits there is no call set-up or clearing. A connection to the frame relaying node must be in place. The logical identifier and the other associated parameters are defined by means of administrative procedures.

4.2.2.2.1 *Layer 1 activation/establishment*

Layer 1 must be permanently active.

A channel has to be established at subscription time.

4.2.2.2.2 *Terminal selection/identification*

Fixed at subscription time.

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[5)] Mandatory features are described in Annex B.

4.2.2.2.3 *Call establishment*

Not applicable.

4.2.2.2.4 *Data transfer*

Sections 4.2.2.1.6 and 4.2.2.1.7.

4.2.2.2.5 *Terminating the call*

Not applicable.

4.2.2.2.6 *Layer 1 deactivation/clearing*

Layer 1 and the supported channel(s) must be permanently active.

4.2.3 *Interrogation/editing*

Not applicable.

4.3 *Exceptional procedures*

4.3.1 *Activation/deactivation/registration*

Not applicable.

4.3.2 *Invocation and operation*

4.3.2.1 *Virtual call*

In case of failure situations due to calling/called user error, user state, or network conditions, appropriate failure indications will be signalled from the network and the call set-up or established call may be terminated.

Q.933 restart procedures may be invoked. Restart procedures apply only to the bearer channel other than semi-permanently connected channel(s). A restart procedure clears all remaining frame mode connections (with their associated call references and DLCI values) active in the specified physical channel or interface and that have not been explicitly cleared prior to invocation of the procedure.

4.3.2.2 *Permanent virtual circuit*

In case of failure situations due to user error, user state, or network conditions, appropriate failure indications may be signalled from the network.

4.3.3 *Interrogation editing*

Not applicable.

4.4 *Alternative procedures*

Not applicable.

4.5 *Verification*

Not applicable.

## 5 Network capabilities for charging

This Recommendation does not cover charging principles;. refer to Recommendations in the D-Series. However, congestion management procedures and quality of service requirements may have charging implications.

### 5.1 *Frame relayed virtual circuit charging*

It shall be possible to charge the subscriber accurately for the frame relay virtual circuit service.

### 5.2 *Frame relayed permanent virtual circuit charging*

It shall be possible to charge the subscriber accurately for the frame relay permanent virtual circuit service.

## 6 Interworking

To interconnect different packet/frame mode bearer services it is necessary to provide interworking between an ISDN offering the bearer service described in this service description and:

- the frame switched bearer service;
- X.25 based services offered by either an ISDN or a PSPDN;
- local area networks (LANs);
- circuit mode bearer services; and
- broadband ISDN services.

For detailed interworking requirements, see I.500-Series Recommendations.

## 7 Interaction with supplementary services

Not applicable.

## 8 Attributes and values of attribute (including the provision of individual bearer services)

### 8.1 *Attributes and values*

TABLE 1/I.233.1

| *Information transfer attribute* | *Values* |
|---|---|
| 1. Information transfer mode | Frame |
| 2. Information transfer rate | Less than or equal to the maximum bit rate of the user information access channel and the throughput of the logical link |
| 3. Information transfer capability | Unrestricted |
| 4. Structure | Service data unit integrity |
| 5. Establishment of communication | Demand/Permanent |
| 6. Symmetry | Bidirectional symmetric |
| 7. Communication configuration | Point-to-point |
| *Access attributes* | *Values* |
| 8. Access channel | D, B or H |
| 9. Access protocol | |
| 9.1 Signalling access protocol layer 1 | Rec. I.430 or I.431 |
| 9.2 Signalling access protocol layer 2 | Rec. Q.921 |
| 9.3 Signalling access protocol layer 3 | Rec. Q.933 |
| 9.4 Information access protocol layer 1 | Rec. I.430 or I.431 |
| 9.5 Information access protocol layer 2 core functions | Core functions<br>Rec. Q.922 |
| 9.6 Information access protocol layer 2 data link control | User specified:<br>Q.922 required for interworking with frame switching and X.25 |

TABLE 1/I.233.1 (*cont.*)

| *General attributes* | *Values* |
|---|---|
| 10. Supplementary services provided<br><br>(provisional list) | Direct-Dialling-In (DDI)<br>Multiple Subscriber Number (MSN)<br>Calling Line Identification Presentation (CLIP)<br>Calling Line Identification Restriction (CLIR)<br>Connected Line Identification Presentation (COLP)<br>Connected Line Identification Restriction (COLR)<br>Malicious Call Identification (MCI)<br>Sub-addressing<br>Call Forwarding Busy (CFB)<br>Call Forwarding Unconditional (CFU)<br>Closed User Group (CUG)<br>Private Numbering Plan<br>Advise of Charge<br>Reverse Charging<br><br>*Note* – The addition of other supplementary services is for further study.<br><br>The definition of new supplementary services equivalent to current X.2/X.25 facilities, is also for further study. |
| 11. Quality of Service | For further study<br>*Note* – Congestion management will affect QOS (see Recommendation I.370). |
| 12. Interworking possibilities | See I.500 Series Recommendations |
| 13. Operational and commercial | For further study<br>*Note* – See § 5. |

8.2 *Provision of individual bearer services*

a) Overall provision[6]: A);

b) Variations of secondary attributes:

TABLE 2/I.233.1

| Information transfer attribute | Establishment of communication | Symmetry | Communication configuration | Provision |
|---|---|---|---|---|
| Information transfer rate (See row 2 of Table 1/I.233.1) | Demand | Bidirectional symmetric | Point-to-point | A |
| Information transfer rate (See row 2 of Table 1/I.233.1) | Permanent | Bidirectional symmetric | Point-to-point | A |

## 9 Dynamic description

Not provided.

ANNEX A

(to Recommendation I.233.1)

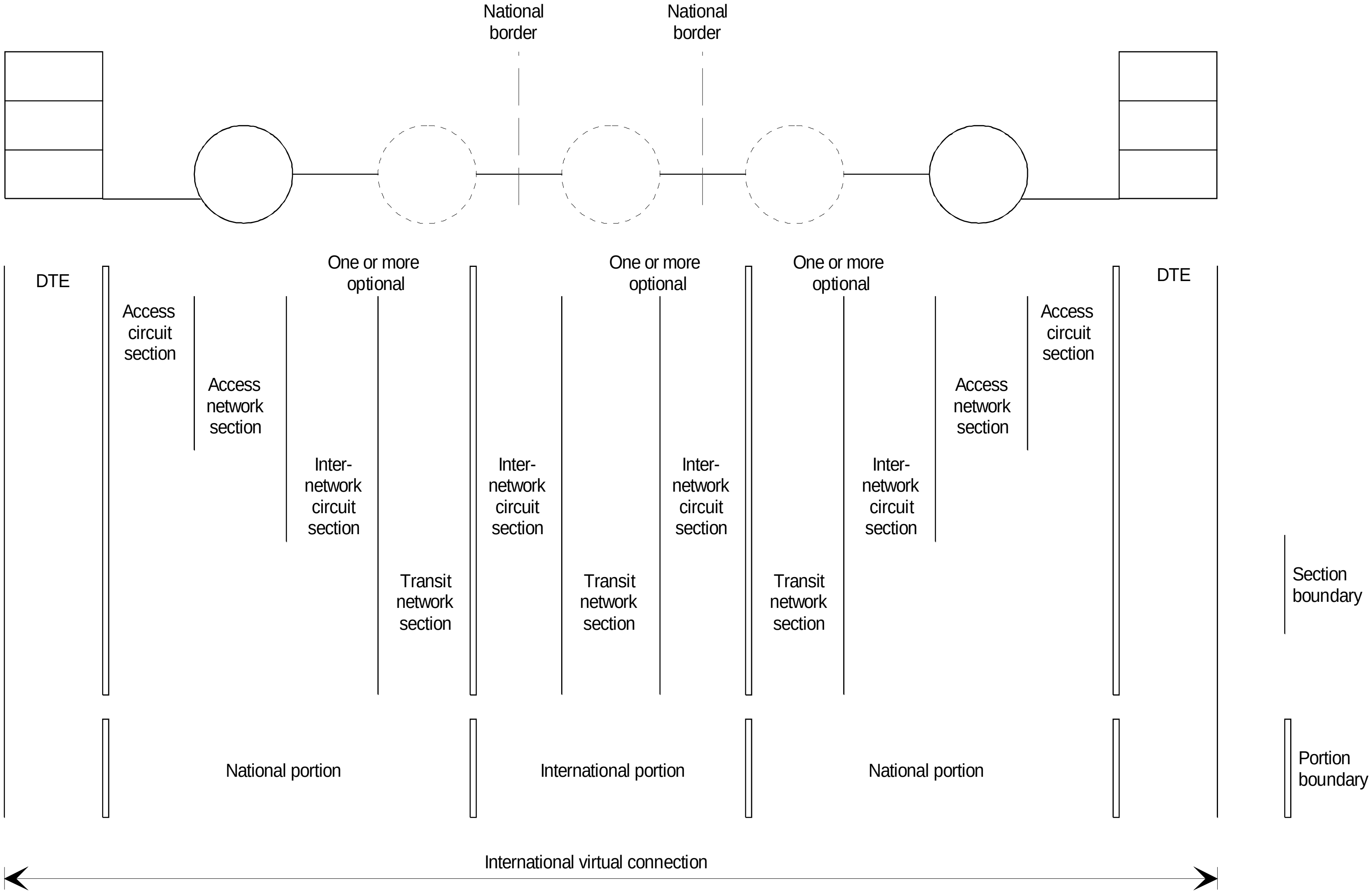
**Definition of terms**

A.1 **throughput**

Throughput for a virtual connection[7] (see Figure A-1/I.233.1 taken from Recommendation X.134) is the number of data bits contained between the address field and the FCS field of the frame successfully transferred in one direction across the virtual connection per unit time. Successful transfer means that the FCS check for each frame is satisfied.

[6] The definition of A (additional) can be found in Recommendation I.230.

[7] Virtual connection section is defined in Recommendation X.134.




DTE Data terminal equipment

T1811960-90

FIGURE A-1/I.233.1

**Virtual connection**

A.2 **transit delay**

Transit delay is defined only between boundaries[8)] of a section. Transit delay of a frame protocol data unit (FPDU) starts at the time $t_1$ at which the first bit of the FPDU crosses the first boundary, and ends at the time $t_2$ at which the last bit of the FPDU crosses the second boundary.

Transit delay = $t_2 - t_1$.

Transit delay for a virtual connection is equal to the summation of the section delays.

A.3 **information integrity**

Information integrity is preserved when all frames delivered by the network satisfy the FCS validation check.

A.4 **access rate**

The data rate of the user access channel (D, B or H). The speed of the access channel determines how much data (maximum rate) the end user can inject into the network.

A.5 **committed burst size (Bc)**

The maximum committed amount of data a user may offer to the network during a time interval Tc. Bc is negotiated at call set-up.

A.6 **excess burst size (Be)**

The maximum allowed amount of data by which a user can exceed Bc during a time interval Tc. This data (Be) is delivered in general with a lower probability than Bc. Be is negotiated at call set-up.

A.7 **committed rate measurement interval (Tc)**

The time interval during which the user is allowed to send only the committed amount of data (Bc) and the excess amount of data (Be). Tc is computed.

A.8 **committed information rate (CIR)**

The information transfer rate which the network is committed to transfer under normal conditions. The rate is averaged over a minimum increment of time Tc. CIR is negotiated at call set-up.

A.9 **congestion management**

This includes network engineering, OAM procedures to detect the onset of congestion, and real-time mechanisms to prevent or recover from congestion. Congestion management includes but is not limited to congestion control, congestion avoidance and congestion recovery as defined below.

A.10 **congestion control**

This refers to real-time mechanisms to prevent and recover from congestion during periods of coincidental peak traffic demands or network overload conditions (e.g. resource failures). Congestion control includes both congestion avoidance and congestion recovery mechanisms.

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[8)] The definition of section boundaries is given in Recommendation X.134.

A.11 **congestion avoidance**

Congestion avoidance procedures refer to procedures initiated at or prior to the onset of mild congestion in order to prevent congestion from becoming severe. Congestion avoidance procedures operate around and within the regions of mild congestion and severe congestion.

A.12 **congestion recovery**

Congestion recovery procedures refers to procedures initiated to prevent congestion from severely degrading the end user perceived quality of service(s) delivered by the network. These procedures are typically initiated when the network has begun to discard frames due to congestion. Congestion recovery procedures operate around and within the region of severe congestion.

A.13 **residual error rate**

The residual error rate is defined for frame mode bearer services and the corresponding layer services. The layer services corresponding to the frame mode bearer services are characterized by the exchange of service data units (SDUs). For frame relaying, SDUs are exchanged at the functional boundary between the core functions of Recommendation Q.922 and the end-to-end protocol implemented above them. The network participates in this exchange by means of frame protocol data units (FPDUs). In frame relaying FPDUs are frames as defined in the core functions of Recommendation Q.922.

The residual error rate for the frame relaying layer service is defined as:

$$R_{fr} = 1 - \frac{\text{Total correct SDUs delivered}}{\text{Total offered SDUs}}$$

The residual error rate for frame relaying is defined as:

$$R_{fr} = 1 - \frac{\text{Total correct SDUs delivered}}{\text{Total offered FPDUs}}$$

A.14 **delivered errored frames**

A delivered frame is defined to be an errored frame when the values of one or more of the bits in the frame is in error, or when some, but not all, bits in the frame are lost bits or extra bits (i.e. bits that were not present in the original signal) (see Recommendation X.140).

A.15 **delivered duplicated frames**

A frame D received by a particular destination user is defined to be a duplicated frame if both of the following conditions are true:

a) D was not generated by the source user;

b) D is exactly the same as a frame that was previously delivered to that destination.

A.16 **delivered out-of-sequence frames**

Consider a sequence of frames $F_1$, $F_2$, $F_3$, ... $F_n$. Assume that $F_1$ is transmitted first, $F_2$ second, ..., $F_n$ last.

A delivered frame $F_i$ is defined to be out-of-sequence if it arrives at the destination after any of the frames $F_{(i+1)}$, $F_{(i+2)}$, ..., $F_n$.

A.17 **lost frames**

A transmitted frame is declared to be a lost frame when the frame is not delivered to the intended destination user within a specified time-out period, and the network is responsible for the non-delivery (see Recommendation X.140).

A.18 **misdelivered frames**

A misdelivered frame is a frame transferred from a source to a destination user other than the intended destination user. It is considered inconsequential whether the information is correct or incorrect in content (see Recommendation X.140).

ANNEX B

(to Recommendation I.233.1)

## Support of the OSI network layer service

B.1 *General*

This annex shows how the frame relaying bearer service supports the OSI network layer service (OSI-NS) described in Recommendation X.213. It should be noted that among all the elements included in the OSI-NS, some are "service provider options". Therefore, a distinction is drawn between elements indicated as optional below, and all of the others, indicated as mandatory.

The OSI-NS consists of three phases:

– connection establishment phase;

– data transfer phase;

– connection release phase.

In the following it is shown how connection establishment and release phases are provided using Q.933 procedures. The data transfer phase is provided by Q.922 plus another protocol.

Also illustrated is the way in which support of the OSI-NS provides a general framework for interworking.

The following functions are required to be supported by the protocol above Q.922:

– segmentation and reassembly (see Note);

– Reset (see Note);

– protocol discriminator;

– expedited data;

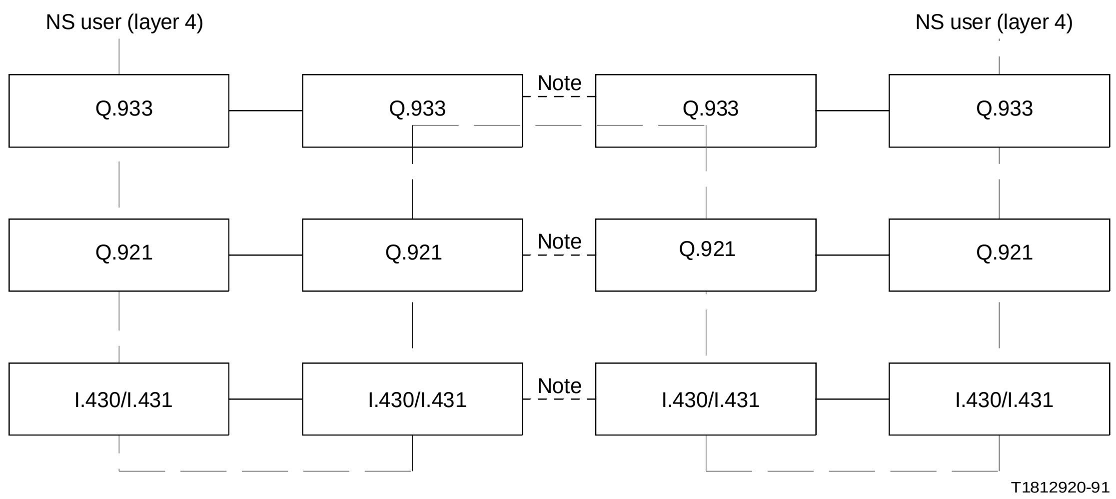
– qualified data indication.

*Note* – There is a strong requirement for these functions.

B.2 *Connection establishment and release*

The connection establishment and release phases of the OSI Network Layer Service (OSI-NS) are provided by Q.933 procedures at layer 3 running above Q.921 (I.441) layer 2 (see Figure B-1/I.233.1). Network service connection establishment and release primitives are mapped into Q.933 messages and exchanged out-of-band on the D-channel or in-band on a signalling data link connection identifier (DLCI).

Recommendation Q.933 provides the protocol capabilities for the negotiation of all the mandatory and optional elements of the service and parameters as recommended in Recommendation X.213, however, it is a service provider decision whether to provide the optional capabilities.




*Note* – These protocols are terminated in the local exchange(s) serving the two end systems. The protocols between the peer entities in the network are network provider specified.

FIGURE B-1/I.233.1

**Connection establishment and release phase**

B.3 *Data transfer*

The OSI data transfer phase is provided by a protocol that resides in the end systems and operates above the link layer (protocol entity X in Figure B-2/I.233.1) on the logical channel obtained during the connection establishment phase. The protocol entity (X) must provide the elements of the network service that were negotiated during the connection establishment phase.

Two approaches are identified to provide for the functions depicted by (X):

1) use of X.25 Data transfer protocol (X.25 DTP);

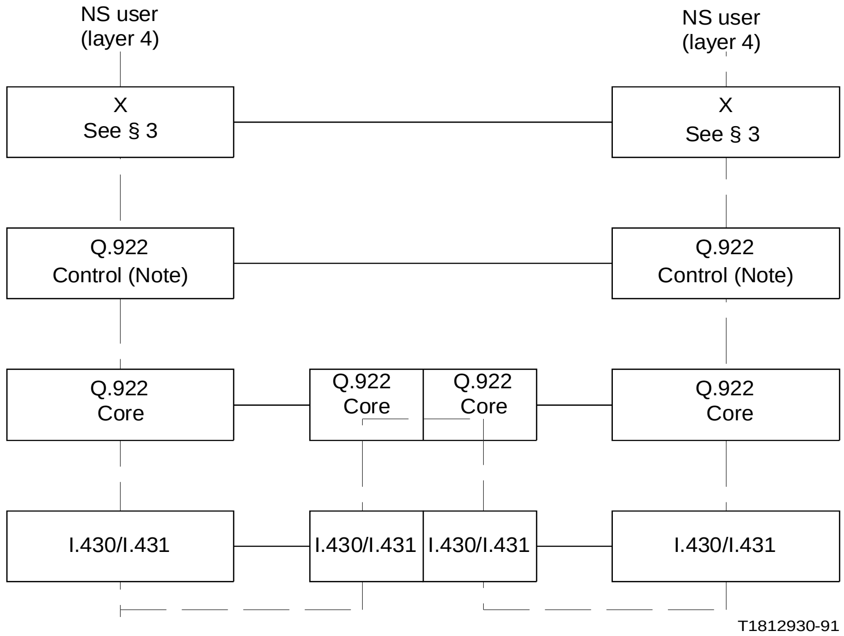
2) a new convergence protocol.

Since approach 2) only ensures the provision of the mandatory features of the OSI-NS, it has to be determined, for a given service context, whether the optional features are required.

B.4 *Interworking*

For cases when there is a need for interworking with X.25/X.31 networks or when all of the mandatory and optional elements of the OSI network service are desired, approach 1) is recommended.

When interworking between networks supporting the X.213 service is required, it can be accomplished through the mapping of protocol elements. In this case some optional elements of the network service may not be supported.



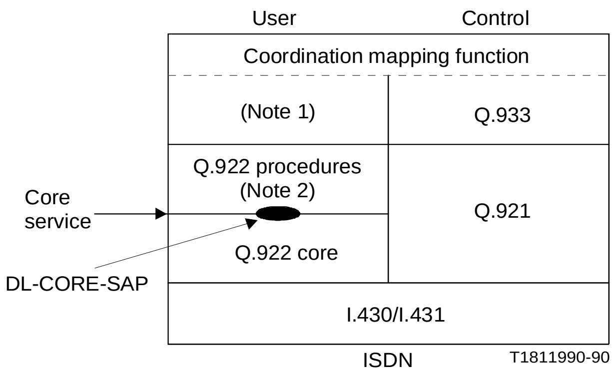

*Note* – Q.922 control is one protocol that may be used. Other standard or proprietary protocols may be used.

FIGURE B-2/I.233.1

**Data transfer phase**

B.5 *Coordination of C-plane U-plane*

A coordination mapping function is needed to provide both call control and data transfer functions of the OSI CONS. This coordination function is shown in Figure B-3/I.233.1.




*Note 1* – Protocol for support of network service may be:
– Convergence protocol according to Recommendation Q.922, Appendix IV.
– X.25 DTP.

*Note 2* – Q.922 is one protocol that may be used. Other standard or proprietary protocols may be used.

FIGURE B-3/I.233.1

**Coordination mapping function**

## ANNEX C

(to Recommendation I.233.1)

**Core service description**

This annex contains the abstract description of the core service, an ISDN layer service in the U-plane.

The core service is provided by the frame relaying bearer service. In this case the core service is supported by a sub-layer of the data link layer of the OSI Reference Model, called the core sub-layer.

It is anticipated that the core service will be supported by the future B-ISDN without duplication of function within the B-ISDN.

The OSI layer service definition conventions (see Recommendation X.210) are the basis of the abstract description of the core service. This overcomes differences in the models used for ISDN and B-ISDN. The abstract description focuses on a Data Transfer service. Call control aspects, in the case of core service provision in the U-plane, are:

– supported by functions in the control plane and coordinated by systems management;

– in the case of semi-permanent core service provision in the core plane, created by fixed allocation of resources.

### C.1 *References*

Recommendation X.200 - Reference Model for open systems interconnection for CCITT applications (see also ISO 7498).

Recommendation X.210 – OSI layer service conventions (see also ISO TR 8509).

Recommendation X.212 – Data link service definition for open systems interconnection for CCITT applications (see also ISO 8886).

Recommendation I.320 – ISDN Protocol Reference Model.

### C.2 *Definitions*

#### C.2.1 *OSI Reference Model definitions*

This annex is based on the concepts developed in the Basic Reference Model and makes use of the following terms defined in Recommendation X.200, as they apply to the core service.

a) (N)-Entity;

b) (N)-Sub-layer;

c) (N)-Service;

d) (N)-Service-access-point;

e) (N)-Connection;

f) (N)-Connection-endpoint;

g) (N)-Connection-endpoint-identifier;

h) (N)-Service-data-unit.

C.2.2 *Service conventions definitions*

This annex makes use of the following terms defined in ISO TR 8509 and Recommendation X.210, as they apply to the core service.

a) service user;

b) service provider;

c) primitive;

d) request;

e) indication.

C.3 *Abbreviations*

| | |
|---|---|
| CEI | Connection endpoint identifier |
| DL-CORE-SAP | Data link layer core service access point |
| CSDU | Core service data unit |

C.4 *Definition of the core service*

C.4.1 *Scope*

This section defines the core service in terms of:

a) the primitive actions and events of the service;

b) the parameters associated with each primitive action and event and the form that they take; and

c) the interrelationship between, and the valid sequences of, these actions and events.

The principal objective of this section is to specify the characteristics of a conceptual core service and thus to guide the development of core protocols. This annex does not specify individual implementation of products, nor does it constrain the implementation of core entities and interfaces within a system. Instead, conformance is achieved through implementation of conforming core protocols that fulfil the core service defined in this annex.

C.4.2 *Overview of the core service*

The core service provides for the connection-oriented transparent transfer of data between core-service users. It makes invisible to these core-service users the way in which supporting communication resources are utilized to achieve this transfer.

In particular, the core service provides the following:

a) independence of the underlying physical layer – The core service relieves core-service users from all concerns, with the exception of Quality of Service considerations, regarding the means for providing the physical layer service (e.g. basic rate or primary rate interface, point-to-point or point-to-multipoint access);

b) transparency of transferred information – The core service provides for the transparent transfer of core service user-data. It does not restrict the content, format, or coding of the information; nor does it ever need to interpret its structure or meaning. It may, however, restrict the maximum length of a core-service-data-unit (CSDU);

*Note* – Addressing (i.e. of core service access points) is not provided by the core service or needed by the core-service user. Selection of a core service access point (CSAP) to be associated with a core connection is a local matter.

C.4.3 *Features of the core service*

The core service provides the following features to the core-service user:

a) core connections of which establishment is coordinated by systems management;

b) agreed Quality of Service for a core connection, coordinated on behalf of the peer core-service users and the core-service provider by protocols in the control-plane and systems management;

c) a means by which core service-data-units are transparently transferred in sequence on a core connection. The transfer of CSDUs, which consist of a limited, integer number of octets, is transparent in that the boundaries and contents of the CSDU are preserved unchanged by the core service and there are no constraints on CSDU content imposed by the core service;

d) associated with each instance of unconfirmed transmission, certain measures of Quality of Service;

e) the means by which the core-service provider may indicate present or incipient congestion to the core-service user;

f) the unconditional, and therefore possibly destructive, release of a core-connection by either of the core-service users or the core-service provider.

C.4.4 *Model of the core service*

The core service is modelled using the abstract model of a layer service defined in the OSI service convention (see Recommendation X.210). The model defines the interactions between the core-service users and the core-service provider which take place at the two DL-CORE-SAPs. Information is passed between the core-service user and the core-service provider by service primitives, which convey parameters. Figure C-1/I.233.1 shows this model.

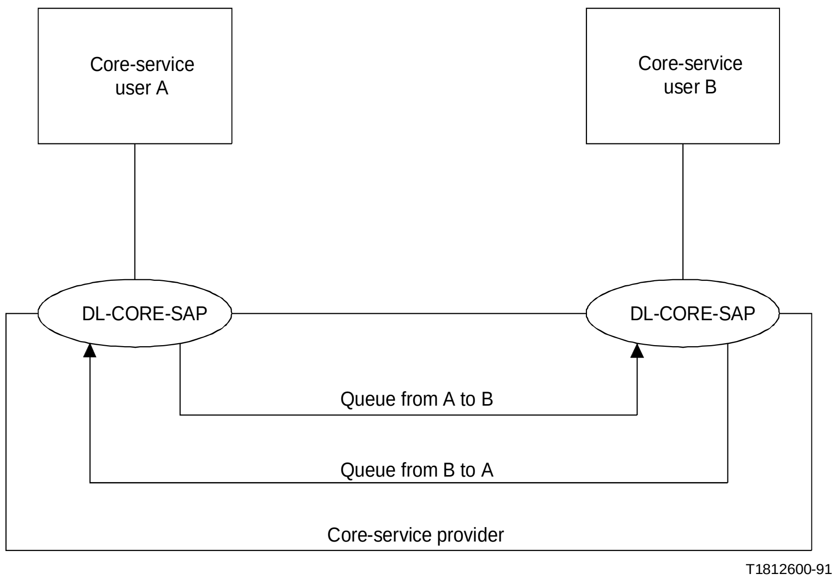



FIGURE C-1/I.233.1

**Model of the core service**

C.4.4.1 *Core connection endpoint identification*

To distinguish among several core connections at a DL-CORE-SAP, a local connection endpoint identification mechanism must be provided. All primitives issued at the DL-CORE-SAP are required to use this mechanism to identify the core connection with which they are associated. Such identification is a local matter, and thus is not described further in this section.

C.4.4.2 *Model of the core connection*

The queue model of a core connection is discussed only as an aid to understanding of the end-to-end service features perceived by the core-service users. It does not attempt to describe all the functions or operations of core entities that are used to provide the core service. No attempt to specify or constrain implementations is implied.

The internal mechanisms which support the operation of the core service are not visible to the core-service user.

C.4.4.3 *Queue model concepts*

The queue model represents the operation of a core connection in the abstract by a pair of queues linking the two DL-CORE-SAPs. There is one queue for each direction of information flow. These queues operate independently. Objects are added to or removed from the queue as a result of interaction at the two DL-CORE-SAPs.

*Note* – The queue model does not model the operation of underlying management protocols.

Only the core-service user may place objects in the queue. The only object defined in this service is a data object, which represents a core-data primitive and its parameters. The queue has the following properties:

1) the queue is empty when it is created by core-connection establishment, and becomes empty with the loss of its contents during connection release;

2) objects are entered into the queue by the sending core-service user. Objects are never entered into the queue by the core-service provider;

3) objects are removed from the queue by the core-service user. They may be deleted from the queue by the core-service provider;

4) objects are removed from the queue in the same order that they were entered;

5) a queue has limited capacity, but this capacity is not necessarily fixed or determinable by the core-service user.

C.4.4.4 *Core-connection establishment*

A pair of queues is associated with a core connection between two DL-CORE-SAPs when the core-service provider establishes a core connection. The queues remain associated with a core-connection until the core connection is released.

Core-connection establishment is coordinated between core-service user and core-service providers through systems management.

C.4.4.5 *Data transfer*

To transfer data, the sending core-service user enters data objects in the queue. The receiving core-service user removes data objects from the queue in the order in which they were entered. Data objects do not interfere with one another, i.e. they are not defined to be destructive (although their cumulative effect may result in some data objects being deleted by the core-service provider).

The core-service provider may delete data objects from the queue at any time. The core-service users negotiate rate and burst size Quality-of-Service sub-parameters with the core-service provider. In general, data objects entered into the queue in excess of the agreed rate and burst size parameters (where this determination is made based on both the rate at which objects are entered and their size) have a higher probability of being deleted than objects entered into the queue within these parameters. The sending core-service user may also indicate data objects which may be deleted with this higher probability. The core-service provider may provide an indication to the sending core-service user and/or the receiving core-service user when the capacity of the queue is exceeded and/or has been reached.

#### C.4.4.6 *Core-connection release*

The core-service provider may release the core connection at any time. This results in disassociation of the queues from the core connection, and destruction of any data objects in the queues.

Core-connection release is coordinated between core-service users and core-service providers through systems management.

### C.4.5 *Sequence of primitives at one core-connection endpoint*

The possible overall allowed sequence of primitives at a core connection endpoint are defined in the state transition diagram of Figure C-2/I.233.1.

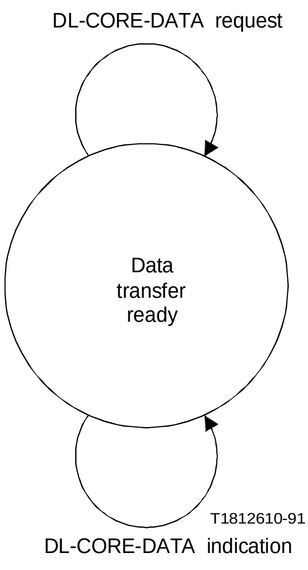



FIGURE C-2/I.233.1

**State transition diagram for a sequence of core-service primitives at a core-connection endpoint**

C.4.6 *Data transfer phase*

The data transfer service primitives provide for an exchange of user data (CSDUs) in either direction or both directions on a core connection. The core service preserves the sequence and boundaries of the CSDUs.

C.4.6.1 *Service primitives and parameters*

Table C-1/I.233.1 summarizes the primitives and parameters for data transfer in the core service.

TABLE C-1/I.233.1

**Core-service primitives and parameters**

| | DL-Core-data request | DL-Core-data indication |
|---|---|---|
| Core-user data | X | X |
| Discard eligibility (optional) | X | |
| Congestion encountered backward (optional) | | X |
| Congestion encountered forward (optional) | | X |
| Connection endpoint identifier (CEI) | X | X |

C.4.6.1.1 *Primitives*

C.4.6.1.1.1 *DL-CORE-DATA*

The DL-CORE-DATA primitives permit peer core-service users to transfer core-user data on an active core connection. This is an unconfirmed service; i.e. there is no confirmation to the core-service user that DL-CORE-DATA has been accepted by the service provider or the peer core-service user, and no response to the core-service provider that core-data has been accepted by the core-service user. Therefore, only the DL-CORE-DATA request and DL-CORE-DATA indication are provided. In addition, as core-protocol-data-units are subject to discarding (e.g. due to congestion or corruption), a DL-CORE-DATA request primitive conveyed to the core-service provider in one peer system will not necessarily cause a corresponding DL-CORE-DATA indication primitive to be conveyed to the core-service user in the other peer system. Further, there is a residual probability of core data misdelivery and/or misordering.

The DL-CORE-DATA indication primitive may have associated with it an optional congestion encountered parameter. The DL-CORE-DATA request primitive may have associated with it an optional transfer priority parameter.

C.4.6.1.2 *Parameters*

C.4.6.1.2.1 *Core-user data*

The core-data parameter conveys data between users of the core service. The minimum size of the core-user-data parameter is one octet. The maximum size of the core-user-data parameter is bounded, and is established either by configuration management or by negotiation by the network layer on behalf of the peer core-entities in the control plane. Core-user data is transferred by the core-service provider without modification or regard to content; however, there is a residual probability that it will be subject to corruption (i.e. insertion, deletion or alteration of bits).

C.4.6.1.2.2 *Congestion*

The congestion parameter conveys information about the capability of the core-service provider to transfer additional core data from the core-service provider to the core-service user. The congestion encountered parameter has two sub-parameters. The congestion encountered forward sub-parameter indicates that the core-service provider has determined incipient congestion in transferring a core-service-data-unit to the core-service user. The congestion backward sub-parameter indicates that the core-service provider is experiencing congestion in transferring core-service-data-units from the core-service user.

C.4.6.1.2.3 *Discard eligibility*

The transfer priority parameter conveys from the core-service user to the core-service provider the priority of the CSDU relative to other CSDUs. It may be used by the core-service provider to select CSDUs to discard, in the event that discard of CSDUs is necessary.

C.4.6.1.2.4 *Core-service user protocol control information*

One bit of core-service user protocol control information is transparently conveyed by the core-service provider on behalf of the core-service user.

*Note* – This capability is provided in support of existing DL-protocols. It is present for pragmatic reasons, and is sanctioned by the OSI-RM.

C.4.6.1.3 *Sequence of primitives*

The sequence of primitives in a successful data transfer is defined in the time sequence diagram in Figure C-3/I.233.1.

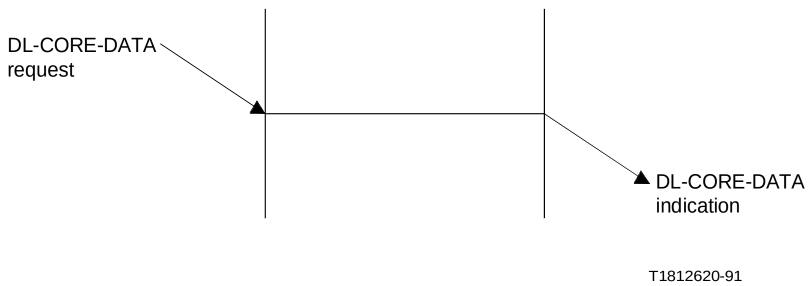



FIGURE C-3/I.233.1

**Sequence of primitives in data transfer**

### C.4.7 *Quality of Service*

The term “Quality of Service” refers to certain characteristics of a core connection as observed between the core-connection endpoints. Quality of Service describes aspects of the core-connection that are attributable solely to the core-service provider.

The core-service Quality of Service parameters can be divided into the following types, based on the way in which their values are determined:

a) those Quality of Service parameters which may be selected on a per-connection basis during the establishment of core connection;

b) those Quality of Service parameters which are not selected during core-connection establishment but whose values are known by other methods.

The following Quality of Service parameters are of type a), selected during core-connection establishment: throughput (i.e. committed information rate, committed burst size, excess burst size), transit delay. Selection procedures are coordinated through system management. Once the core connection is established, throughout the lifetime of the core connection the agreed Quality of Service parameter can be reselected at any point by the core-service provider, and there is no guarantee that the original values will be maintained. The core-service users may or may not receive notification of changes in Quality of Service.

The following Quality of Service parameters are of type b), but not selected during core-connection establishment: residual error rate (corruption, extra, loss).

Resilience, protection and priority, which are part of the Quality of Service of other OSI service definitions, are not presently described and are for further study.

*Note* – Misdelivered frames are accounted for as “extra” and “loss”.

#### C.4.7.1 *Throughput*

The throughput sub-parameters are defined in Annex A.

#### C.4.7.2 *Transit delay*

Transit delay is the elapsed time between DL-CORE-DATA request primitives and the corresponding DL-CORE-DATA indication primitives. Elapsed time values are calculated only on CSDUs that are successfully transferred.

*Note* – Transit delay in this service definition takes into account those delays associated with the local systems containing the core-service users as well as those defined in Annex A.

## ANNEX D

(to Recommendation I.233.1)

**Provision of the core service by the**
**Frame Relaying Bearer Service**

### D.1 *Introduction*

This annex contains a definition of the core sub-layer of the data link layer of the OSI Reference Model. The core service is provided by the frame relaying bearer service, and networks supporting the frame relay bearer service perform relaying and routing at the core sub-layer. The concepts of the OSI Reference Model (see Recommendation X.200), the OSI service conventions (see Recommendation X.210), and the ISDN Protocol Reference Model (see Recommendation I.320) are used.

The requirements of the frame relay bearer service are described by use of the concept of sub-layering (see § 5.2 of Recommendation/X.200). The data link layer is divided into two sub-layers, which are called the core sub-layer and the data link control sub-layer. The core sub-layer provides only those functions needed to take advantage of the statistical properties of communications. The data link control sub-layer enhances the core sub-layer to support the OSI data link service. The internal structure of the data link layer is illustrated in Figure D-1/I.233.1.

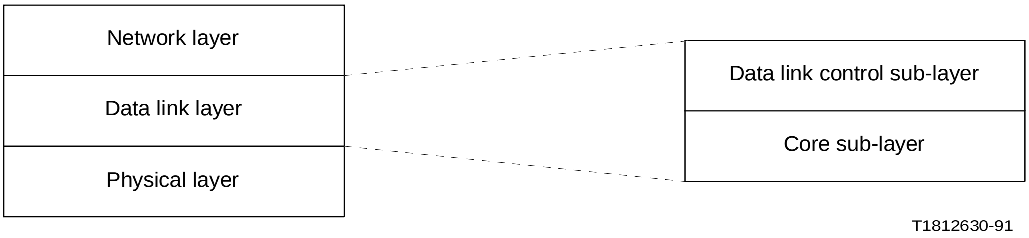



FIGURE D-1/I.233.1

**Internal structure of the data link layer**

D.2 *Definition of the core service as sub-layer service of the data link layer*

This section defines the services provided by the core sub-layer of the data link layer to the data link control sub-layer of the data link layer at the boundary between the core and data link control sub-layers. This relationship is illustrated in Figure D-2/I.233.1.

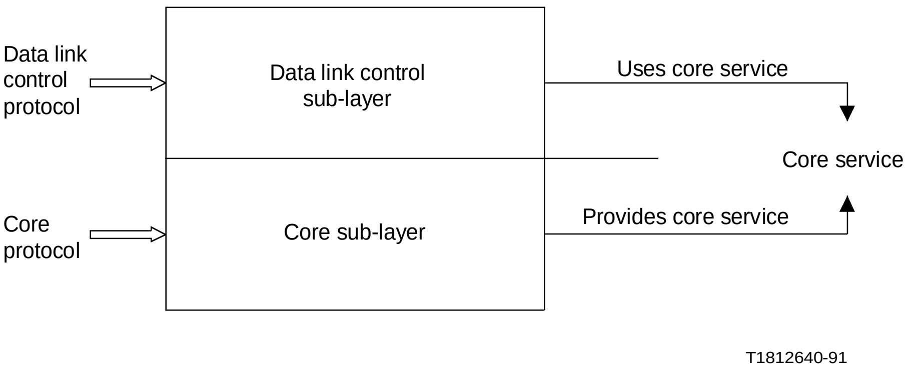



FIGURE D-2/I.233.1

**Internal structure of the data link layer**

D.3 *Definition of the core sub-layer*

The core sub-layer provides those data link functions necessary to permit routing and relaying, but excludes those associated with sequencing, most forms of error detection, error recovery and flow control. As a result the core sub-layer provides an unreliable service which may be enhanced if necessary.

D.3.1 *Services provided to the data link control sub-layer*

The core service provides the following services or elements of service:

a) core connection;

b) core-service-data-units;

c) core-connection-endpoint-identifiers;

d) Quality of Service parameters.

D.3.1.1 *Core connection*

The core sub-layer provides one or more core connections between two CSAPs.

D.3.1.2 *Core-service-data-unit*

The core sub-layer provides for exchange of core-service-data-units across a core connection. The size of a core-service-data-unit is variable, and is bounded by agreement of the peer core-entities.

D.3.1.3 *Core-connection-endpoint-identifier*

The core sub-layer provides core-connection-endpoint-identifiers that can be used to identify the correspondent core connection.

D.3.1.4 *Quality of Service parameters*

Quality of Service parameters may be selectable for a particular core connection. The Quality of Service of a core connection is derived from the concatenated Physical connections supporting it and the behaviour of the peer core-entities.

D.3.2 *Functions within the core sub-layer*

The following functions are performed by the core sub-layer:

a) core-connection provision;

b) core-service-data-unit-mapping;

c) delimiting, synchronization and transparency;

d) error detection;

e) multiplexing;

f) congestion control (including throughput enforcement).

D.3.2.1 *Core-connection establishment and release*

Core connections are established and released on activated Physical connections by functions in the control plane and/or system management. There is no exchange of core-service primitives or core-protocol-data-units for establishment and release of core connections.

D.3.2.2 *Core-service-data-unit-mapping*

This function maps core-service-data-units onto core-protocol-data-units. There is no opportunity at this sub-layer for segmentation and reassembly.

D.3.2.3 *Delimiting, synchronization and transparency*

These functions (collectively known as framing) provide for grouping of bits provided by the physical layer service into core-protocol-data-units (CPDUs), for recognizing these groups of bits from among all other bits presented by the physical layer, and for ensuring that CSDUs may be transferred without regard to their content.

D.3.2.4 *Error detection*

This function detects, with some large but finite probability, the corruption of core-protocol-data-units by alteration, loss or insertion of bits. When errors are detected, the entire CSDU contained in the CPDU is not transferred across the sub-layer boundary.

D.3.2.5 *Multiplexing*

This function permits one or more core connections to exist across a single physical connection.

D.3.2.6 *Relaying*

Core connections are provided by core entities in end systems, but may also involve intermediate systems which provide relaying at the core sub-layer. Routing is performed by the Network Layer on behalf of the core sub-layer.

D.3.2.7 *Congestion control*

This function permits core entities to detect congestion, to optionally determine whether particular core associations exceed their agreed throughput parameters, to optionally notify peer core-entities of congestion conditions, and to discard core-protocol-data-units in response to congestion.

ANNEX E

(to Recommendation I.233.1)

**Alphabetical list of abbreviations used in this Recommendation**

| | |
|---|---|
| CEI | Connection endpoint identifier |
| CFB | Call forwarding busy |
| CFU | Call forwarding unconditional |
| CIR | Committed information rate |
| CLIP | Calling line identification presentation |
| CLIR | Calling line identification restriction |
| COLP | Connected line identification presentation |
| COLR | Connected line identification restriction |
| CPDU | Core-protocol-data-unit |

| | |
|---|---|
| CSDU | Core-service-data-unit |
| CUG | Closed user group |
| DDI | Direct-dialling-in |
| DL-CORE-SAP | Core service access point |
| FCS | Frame check sequence |
| LAN | Local area network |
| MCI | Malicious call identification |
| MSN | Multiple subscriber number |
| OSI-NS | OSI network layer service |
| PRA | Primary rate access |
| PVC | Permanent virtual circuit |
| SDU | Service data unit |

# ISDN FRAME SWITCHING BEARER SERVICE

## 1 Introduction

Recommendation I.210 describes the principles for defining telecommunication services supported by an ISDN including the concept of bearer services, teleservices and supplementary services. It also provides the means for the definition and description of such services. The purpose of this document is to describe the frame switching bearer service and to recommend the method of its provision in an ISDN. The definition and description of this service form the basis to define the network capabilities required for the support of the service in an ISDN. According to Recommendation I.210 a stage 1 service description uses three steps:

– prose description;

– static description;

– dynamic description.

These steps begin in §§ 1, 8 and 9 respectively.

## 2 Definition

The **frame switching bearer service** provides bidirectional transfer of service data units (SDUs) from one S or T reference point to another with the order preserved. The service data units are routed through the network by appropriate layer 2 PDUs on the basis of an attached label. This label is a logical identifier with local significance (termed DLCI in the protocol description).

The user network interface structure at the S or T reference point allows for the establishment of multiple virtual calls and/or permanent virtual circuits to many destinations. This service is generally available on the following ISDN access arrangements: point-to-multipoint (passive bus) and point-to-point (NT2).

It is a requirement of this service description to show how the OSI network layer service could be supported.

## 3 Description

### 3.1 *General description*

The frame switching bearer service has the following characteristics:

1) All C-plane procedures, if needed, are performed in a logically separate manner using protocol procedures that are integrated across all ISDN telecommunication services.

2) The U-plane procedures at layer 1 are based on Recommendations I.430/I.431. Layer 2 procedures are based on Recommendation Q.922. These layer 2 procedures allow for the statistical multiplexing of user information flows immediately above layer 1 functions.

This bearer service provides the bidirectional transfer of service data units (frames) from one S or T reference point to another with the order preserved.

This bearer service:

1) provides for the acknowledged transport of frames;
2) detects and recovers from transmission, format, and operational error;
3) detects and recovers from lost or duplicated frames;
4) provides flow control.

The functions above are based on Q.922 procedures with appropriate extensions. It provides service quality that is characterized by the values of the following parameters.

1) throughput;
2) access rate;
3) committed information rate;
4) committed burst size;
5) excess burst size;
6) transit delay;
7) residual error rate;
8) delivered errored frames;
9) delivered duplicated frames;
10) delivered out-of-sequence frames;
11) lost frames;
12) misdelivered frames.

### 3.2 *Specific terminology*

See Annex A.

### 3.3 *Qualifications*

Not applicable.

### 3.4 *Applications*

The frame mode bearer service described in this Recommendation aims to support a wide range of data applications and rates from very low, to high (typically 2 Mbit/s).

## 4 Procedures

### 4.1 *Provision/withdrawal*

This bearer service is offered with several subscription options which apply separately to each ISDN number or group of ISDN numbers on the interface. For each subscription option, only one value can be selected. Subscription options for the interface are summarized below:

– general subscription to the frame switching bearer service[1];
– subscription to the frame switching bearer service with user defined service profile;

[1] Some networks may not require specific subscription to the frame switching bearer service since it may be offered as a default for general ISDN subscription.

– subscription to the conveyance of sub-addresses for terminal selection and/or conveyance of NSAP addresses for support of the OSI network layer service;

– subscription to the Multiple Subscriber Number (MSN) or Direct-Dialling-In (DDI) supplementary services may be required for terminal selection purposes.

In general there will be a limit on the number of information channels available at the user-network interface:

– maximum number of total calls present (frame switched VCs) per interface = N;

– maximum number of total calls present (frame switched VCs) per channel (D, B, H) = M.

4.2 *Normal procedures*

All user-network signalling takes place using logically separate messages.

On the user side of the S or T reference point, Recommendation I.430 or I.431 provide the layer 1 protocol for the U (user) and C (control) planes. The C-plane uses the D-channel with Recommendation Q.921 and Q.933 Recommendations as the layer 2 and 3 protocols respectively. For permanent virtual circuits (PVCs), no real-time call establishment is necessary and any parameters are agreed upon at subscription time. The U-plane may use any channel (D, B or H) on which the user implements Recommendation Q.922.

4.2.1 *Activation/deactivation/registration*

Not applicable.

4.2.2 *Invocation and operation*

Virtual call and permanent virtual circuit procedures can be invoked and operated concurrently by a given terminal.

4.2.2.1 *Virtual call procedures*

Before procedures for originating the service are invoked, a layer 1 physical channel and a reliable data link connection for signalling are required.

4.2.2.1.1 *Originating the service (call set-up)*

The call is originated by the user requesting from the network the required bearer service, with this request including a number identifying the called user. Other information required for the bearer service and additional information (e.g. calling line identity) may also be included.

There are three possible channel types (D, B, H) that could be used. Moreover, there are two possible physical channel access arrangements:

– demand establishment of the channel;

– semi-permanent establishment of the channel.

In the first arrangement, if a physical channel is not established, or already established channels have no free capacity, another channel (if available) is established using Q.933 procedures.

In the second arrangement, and also for the D-channel, no dynamic establishment procedure is required.

Once a physical channel has been established either dynamically or semi-permanently then, in the virtual call case, the value of the logical identifier and the other associated parameters, as defined in § 2, are negotiated during the call set-up by means of C-plane procedures. Depending on the parameters requested, the network may accept or reject the call.

The user network interface structure at the S or T reference point allows for the establishment of multiple virtual calls and/or permanent virtual circuits to one or more destination(s).

Since it is a requirement of this service description to show how the OSI network layer service could be supported, Rec. Q.933 will be used to carry the connection establishment and release primitives and parameters for the OSI network service. See Annex B for details.

4.2.2.1.2 *Indications during call set-up*

If interworking takes place, an indication of such interworking is required. The user can then decide whether to proceed with the interworking or to clear the call. See § 6 and I.500-Series Recommendations.

See also Annex B for indications specific to the support of the OSI network service.

4.2.2.1.3 *Terminal selection/identification*

The Multiple Subscriber Number (MSN) and Direct-Dialling-In (DDI) supplementary Services as well as sub-addressing are methods applicable to terminal selection and identification.

4.2.2.1.4 *Call notification*

Q.933 procedures are used to notify the user of incoming calls.

*Note* – Channel negotiation allows the called user to request that a call be offered on a specific channel, D, B or H.

4.2.2.1.5 *Synchronization between C-plane and U-plane*

In some cases there is a gap between the time a connect confirmation is received and when the actual connection is established. It may be necessary to verify the connection prior to the beginning of data transfer. This should be accomplished end-to-end in the U-plane.

4.2.2.1.6 *Virtual call procedures U-plane (Data Transfer)*

Figure 1/I.233.2 illustrates the U-plane configuration for this service. Protocol functions up to and including layer 3 are shown. The network terminates the layer 2 (Q.922) protocol.

The service can be offered on both basic access and primary rate interfaces and on any ISDN channel (D, B and H). Some restrictions, e.g. frame size, apply when in an end-to-end connection at least one of the access channels is the D (16/64 kbit/s) channel.

The data transfer phase of the OSI connection oriented network layer service (CONS/Recommendation X.213) can be provided by using X.25 DTP, appropriate ISO layer 3 protocols or by a convergence protocol above Q.922. In the latter case only the mandatory[2)] features' of the network service as currently defined in Recommendation X.213 are provided. Even though these arrangements are permitted, the use of Q.922 and X.25 DTP protocols is preferred because it allows for easy interworking with the frame relay bearer service and networks using Recommendation X.25. See Annex B for details.

4.2.2.1.7 *Congestion management and control*

Congestion in the U-plane occurs when traffic arriving at a resource (e.g. memory or processor), exceeds the network engineered level. It can also occur for other reasons (e.g. equipment failure). Network congestion causes degradation to throughput and delay performance.

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2) Mandatory features are described in Annex B.

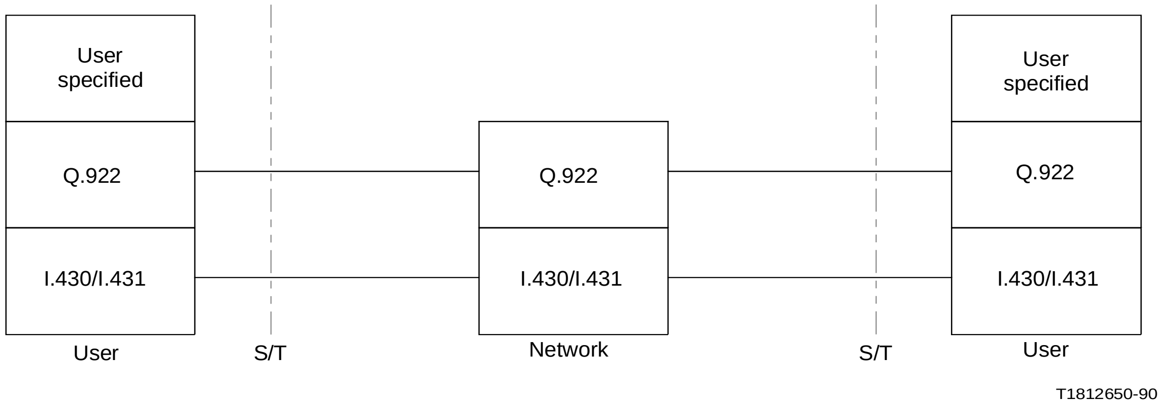



FIGURE 1/I.233.2

**U-plane configuration**

An effective congestion management strategy should include network engineering and operational, administrative and maintenance (OAM) procedures to detect the onset of congestion, prevent sustained network congestion and ensure that network resources are used efficiently. In addition, distributed real-time congestion controls are necessary to prevent and recover from congestion during infrequent periods of coincidental peak traffic demands.

Congestion avoidance and recovery schemes are best distributed since traffic monitoring is most effectively done at the congested (network) resource while traffic rate control is best done by the user terminal.

4.2.2.1.8 *Terminating the call*

When the call is cleared all resources used by the call are cleared (e.g. label, call reference value, etc.). In the demand channel establishment arrangement if no calls are present and if the user or network desires, either the user or the network may clear the physical channel.

If the network desires it may deactivate the C-plane layer 2 and interface layer 1.

*Note* – Primary rate access (PRA) has no defined deactivated state.

In the semi-permanent channel access arrangement the network or user may only deactivate the C-plane layer 2.

The frame switched virtual call may be terminated by either or both of the users by indicating this to the network. In either case, an appropriate indication is sent to the other user. The network may terminate the call for several reasons, for example, severe congestion, error or failure conditions.

4.2.2.2 *Permanent virtual circuit procedures*

For permanent virtual circuits there is no call set up or clearing. A connection to the frame switching node must be in place. The logical identifier and the other associated parameters are defined by means of administrative procedures.

4.2.2.2.1 *Layer 1 activation/establishment*

Layer 1 must be permanently active.

A channel has to be established at subscription time.

4.2.2.2.2 *Terminal selection/identification*

Fixed at subscription time.

4.2.2.2.3 *Call establishment*

Not applicable.

4.2.2.2.4 *Data transfer*

See §§ 4.2.2.1.6 and 4.2.2.1.7.

4.2.2.2.5 *Terminating the call*

Not applicable.

4.2.2.2.6 *Layer 1 deactivation/clearing*

Layer 1 and the supported channel(s) must be permanently active.

4.2.3 *Interrogating/editing*

Not applicable.

4.3 *Exceptional procedures*

4.3.1 *Activation/deactivation/registration*

Not applicable.

4.3.2 *Invocation and operation*

4.3.2.1 *Virtual call*

In case of failure situations due to calling/called user error, user state, or network conditions, appropriate failure indications will be signalled from the network and the call set-up or established call may be terminated.

Q.933 restart procedures may be invoked. Restart procedures apply only to the bearer channel other than semi-permanently connected channel(s). A restart procedure clears all remaining frame mode connections (with their associated call references and DLCI values) active in the specified physical channel or interface that has not been explicitly cleared prior to invocation of the procedure.

4.3.2.2 *Permanent virtual circuit*

In case of failure situations due to user error, user state, or network conditions, appropriate failure indications may be signalled from the network.

### 4.3.3 *Interrogation/editing*

Not applicable.

### 4.4 *Alternative procedures*

Not applicable.

### 4.5 *Verification*

Not applicable.

## 5 Network capabilities for charging

This Recommendation does not cover charging principles. Refer to Recommendations in the D-Series. However, Quality of service requirements may have charging implications.

### 5.1 *Frame switched virtual circuit charging*

It shall be possible to charge the subscriber accurately for the frame switched virtual circuit service.

### 5.2 *Frame switched permanent virtual circuit charging*

It shall be possible to charge the subscriber accurately for the frame switched virtual circuit service.

## 6 Interworking

To interconnect different packet/frame mode bearer services it is necessary to provide interworking between an ISDN offering the bearer service described in this service description and:

– the frame relaying bearer service;

– X.25 based services offered by either an ISDN or a PSPDN;

– local area networks (LANs);

– circuit mode bearer services; and

– broadband ISDN services.

For detailed interworking requirements see I.500-Series Recommendations.

## 7 Interaction with supplementary services

Not applicable.

## 8 Attributes and values of attributes (including the provision of individual bearer services)

### 8.1 *Attributes and values*

TABLE 1/I.233.2

| *Information transfer attributes* | *Values* |
|---|---|
| 1. Information transfer mode | Frame |
| 2. Information transfer rate | Less than or equal to the maximum bit rate of the user information access channel and the throughput of the logical link |
| 3. Information transfer capability | Unrestricted |
| 4. Structure | Service data unit integrity |
| 5. Establishment of communication | Demand/Permanent |
| 6. Symmetry | Bidirectional symmetric |
| 7. Communication configuration | Point-to-point |
| *Access attributes* | *Values* |
| 8. Access channel | D, B or H |
| 9. Access protocol | |
| 9.1 Signalling access protocol layer 1 | Rec. I.430 or I.431 |
| 9.2 Signalling access protocol layer 2 | Rec. Q.921 |
| 9.3 Signalling access protocol layer 3 | Rec. Q.933 |
| 9.4 Information access protocol layer 1 | Recs. I.430 or I.431 |
| 9.5 Information access protocol layer 2 core functions | Rec. Q.922 |
| 9.6 Information access protocol layer 2 data link control | Rec. Q.922 |

Table 1/233.2 (*Cont.*)

| *General attributes* | *Values* |
|---|---|
| 10. Supplementary services provided<br><br>(provisional list) | Direct-Dialling-In (DDI)<br>Multiple Subscriber Number (MSN)<br>Calling Line Identification Presentation (CLIP)<br>Calling Line Identification Restriction (CLIR)<br>Connected Line Identification Restriction (CLOP)<br>Connected Line Identification Restriction (COLR)<br>Malicious Call Identifications (MCI)<br>Sub-addressing<br>Call Forwarding Busy (CFB)<br>Forwarding Unconditional (CFU)<br>Closed User Group (CUG)<br>Private Numbering Plan<br>Advice of Charge<br>Reverse Charging<br><br>*Note* – The addition of other supplementary services is for further study.<br><br>The definition of new supplementary services equivalent to current X.2/X.25 facilities, is also for further study |
| 11. Quality of Service | For further study<br>*Note* – Congestion management will affect Quality of Service (see Recommendation I.370). |
| 12. Interworking possibilities | See I.500-Series Recommendations |
| 13. Operational and commercial | For further study<br>*Note* – See § 5. |

8.2 *Provision of individual bearer services*

a) Overall provision[3]: A;

b) Variations of secondary attributes:

TABLE 2/I.233.2

| Information transfer attribute | Establishment of communication | Symmetry | Communication configuration | Provision |
|---|---|---|---|---|
| Information transfer rate (See row 2 of Table 1/I.233.2) | Demand | Bidirectional symmetric | Point-to-point | A |
| Information transfer rate (See row 2 of Table 1/I.233.2) | Permanent | Bidirectional symmetric | Point-to-point | A |

## 9 Dynamic description

Not provided.

ANNEX A

(to Recommendation I.233.2)

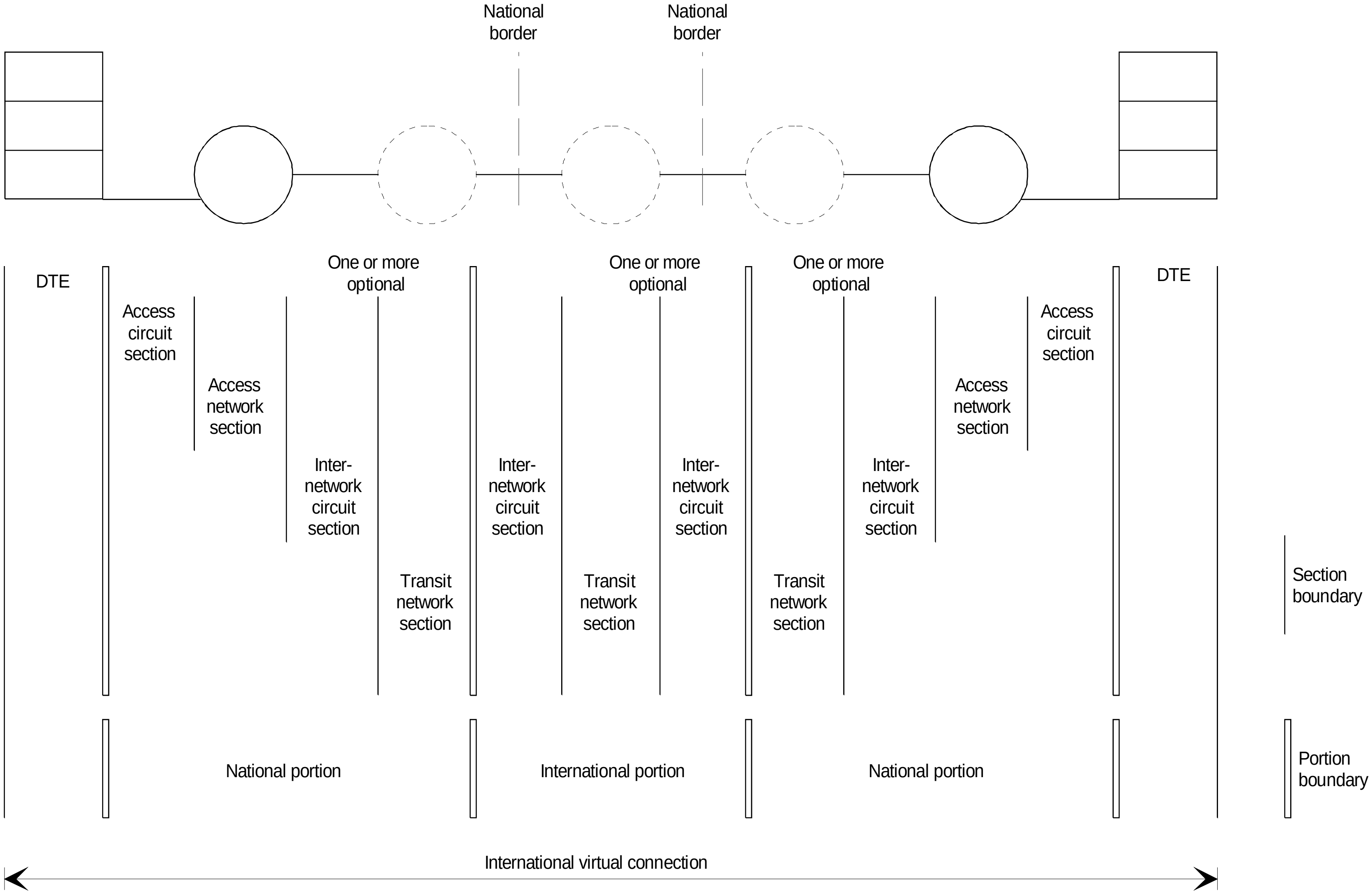
**Definition of terms**

**A.1 throughput**

Throughput for a virtual connection section[4] (see Figure A-1/I.233.2 taken from Recommendation X.134) is the number of data bits contained between the control field and the FCS field of the frame successfully transferred in one direction across that section per unit time. Successful transfer means that the layer 2 data link procedures are satisfied without any error condition.

[3] The definition of A (additional) can be found in Recommendation I.230.

[4] Virtual connection section is defined in Recommendation X.134.




DTE Data terminal equipment

T1811960-90

FIGURE A-1/I.233.1

**Virtual connection**

Throughput for a virtual connection is limited to the lowest throughput value of any section in the virtual connection.

## A.2 transit delay

Transit delay is defined only between boundaries[5] of a section. Transit delay of a frame protocol data unit (FPDU) starts at the time $t_1$ at which the first bit of the FPDU crosses the first boundary, and ends at the time $t_2$ at which the last bit of the FPDU crosses the second boundary.

Transit delay = $t_2 - t_1$.

Transit delay for a virtual connection is equal to the summation of the section delays.

## A.3 information integrity

Information integrity is preserved when all frames are delivered by the network without any error condition and satisfy the FCS validation check.

## A.4 residual error rate

Residual error rate is defined for frame mode bearer services and the corresponding layer services. The layer services corresponding to the frame mode bearer services are characterized by the exchange of service data units (SDUs). For frame switching, SDUs are exchanged at the functional boundary between the complete Q.922 functions and the end-to-end functions implemented above Q.922.

The network participates in this exchange by means of frame protocol data units (FPDUs). In frame switching, FPDUs are frames as defined in Recommendation Q.922.

The residual error rate for frame switching layer service is defined as:

$$R_{fr} = 1 - \frac{\text{Total correct SDUs delivered}}{\text{Total offered SDUs}}$$

The residual error rate for frame switching is defined as:

$$R_{fs} = 1 - \frac{\text{Total correct FPDUs delivered}}{\text{Total offered FPDUs}}.$$

## A.5 delivered errored frames

A delivered frame is defined to be an errored frame when the values of one or more of the bits in the frame is in error, or when some, but not all, bits in the frame are lost bits or extra bits (i.e. bits that were not present in the original signal) (see Recommendation X.140).

## A.6 delivered duplicated frames

A frame D received by a particular destination user is defined to be a duplicated frame if both of the following conditions are true:

a) D was not generated by the source user;

b) D is exactly the same as a frame that was previously delivered to that destination.

---

[5] The definition of section boundaries is given in Recommendation X.134.

A.7 **delivered out-of-sequence frames**

Consider a sequence of frames $F_1$, $F_2$, $F_3$, ..., $F_n$, Assume that $F_1$ is transmitted first, $F_2$ second, ..., $F_n$ last.

A delivered frame $F_i$ is defined to be out-of-sequence if it arrives at the destination after any of the frames $F_{(i+1)}$, $F_{(i+2)}$, ..., $F_n$.

A.8 **lost frames**

A transmitted frame is declared to be a lost frame when the frame is not delivered to the intended destination user within a specified time-out period, and the network is responsible for the non-delivery (see Recommendation X.140).

A.9 **misdelivered frames**

A misdelivered frame is a frame transferred from a source to a destination user other than the intended destination user. It is considered inconsequential whether the information is correct or incorrect in content (see Recommendation X.140).

ANNEX B

(to Recommendation I.233.2)

**Support of the OSI network layer service**

B.1 *General*

This annex shows how the frame switching bearer service supports the OSI network layer service (OSI-NS) described in Recommendation X.213. It should be noted that among all the elements included in the OSI-NS, some are "service provider options". Therefore, a distinction is drawn between elements indicated as optional below, and all of the others, indicated as mandatory.

The OSI-NS consists of three phases:

– connection establishment phase;

– data transfer phase;

– connection release phase.

In the following it is shown how connection establishment and release phases are provided using Q.933 procedures. The data transfer phase is provided by Q.922 plus another protocol.

Also illustrated is the way in which support of the OSI-NS provides a general framework for interworking.

The following functions are required to be supported by the protocol above Q.922:

– segmentation and reassembly (see Note);

– reset (see Note);

– protocol discriminator;

– expedited data;

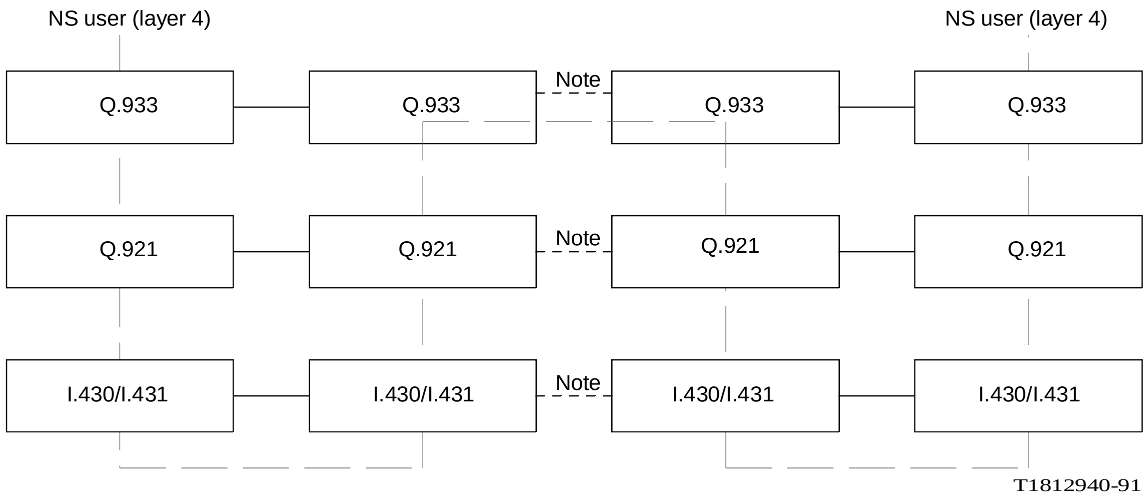
– qualified data indication.

*Note* – There is a strong requirement for these functions.

B.2 *Connection establishment and release*

The connection establishment and release phases of the OSI network layer service (OSI-NS) are provided by Q.933 procedures at layer 3 running above Q.921 at layer 2 (see Figure B-1/I.233.2). Network service connection establishment and release primitives are mapped into Q.933 messages and exchanged out-of-band on the D-channel or in-band on a signalling DLCI.

Recommendation Q.933 provides the protocol capabilities for the negotiation of all the mandatory and optional elements of the service and parameters as recommended in Recommendation X.213, however, it is a service provider decision whether to provide the optional capabilities.




*Note* – These protocols are terminated in the local exchange(s) serving the two end systems. The protocols between the peer entities in the network are network provider specified.

FIGURE B-1/I.233.2

**Connection establishment and release phase**

B.3 *Data transfer*

The OSI data transfer phase is provided by a protocol that resides in the end systems and operates above the link layer (protocol entity X in Figure B-2/I.233.2) on the logical channel obtained during the connection establishment phase. The protocol entity (X) must provide the elements of the network service that were negotiated during the connection establishment phase.

Two approaches are identified to provide for the functions depicted by (X):

1) use of X.25 data transfer protocol (X.25);

2) a new convergence protocol.

Since approach 2) only ensures the provision of the mandatory features of the OSI-NS it has to be determined, for a given service context, whether the optional features are required.

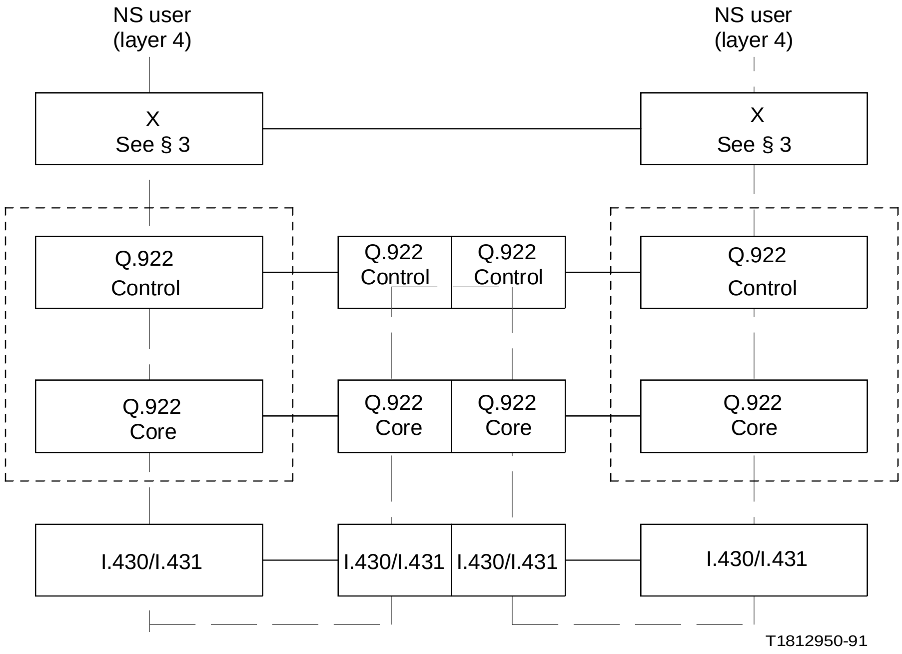



FIGURE B-2/I.233.2

**Data transfer phase**

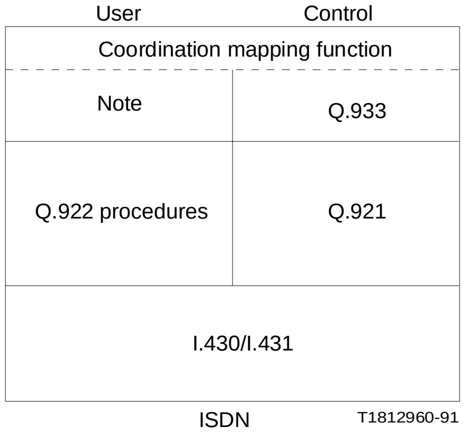
B.4 *Interworking*

For cases when there is a need for interworking with X.25/X.31 networks or when all of the mandatory and optional elements of the OSI network service are desired, approach 1) is recommended.

When interworking between networks supporting the X.213 service is required, it can be accomplished through the mapping of protocol elements. In this case some optional elements of the network service may not be supported.

B.5 *Coordination of C-plane and U-plane*

A coordination mapping function is needed to provide both call control and data transfer functions of the OSI CONS. This coordination function is shown in Figure B-3/I.233.2.




*Note* – Protocol for support of network service may be:
– Convergence protocol according to Recommendation Q.922, Appendix IV.
– X.25 DTP.

FIGURE B-3/I.233.2
**Coordination mapping function**

## ANNEX C

(to Recomendation I.233.2)

### Alphabetical list of abbreviations used in this Recommendation

CFB Call forwarding busy

CFU Call forwarding unconditional

CLIP Calling line identification presentation

CLIR Calling line identification restriction

COLP Connected line identification presentation

COLR Connected line identification restriction

CUG Closed user group

DDI Direct-dialling-in

LAN Local area network

MCI Malicious call identification

MSN Multiple subscriber number

OSI-NS OSI network layer service

PRA Primary rate access

PVC Permanent virtual circuit

SDU Service data unit