INTERNATIONAL TELECOMMUNICATION UNION

ITU-T Q.933

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

(10/95)

DIGITAL SUBSCRIBER SIGNALLING SYSTEM No. 1

INTEGRATED SERVICES DIGITAL NETWORK (ISDN) DIGITAL SUBSCRIBER SIGNALLING SYSTEM No. 1 (DSS 1) – SIGNALLING SPECIFICATIONS FOR FRAME MODE SWITCHED AND PERMANENT VIRTUAL CONNECTION CONTROL AND STATUS MONITORING

ITU-T Recommendation Q.933

(Previously "CCITT Recommendation")

FOREWORD

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

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

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

ITU-T Recommendation Q.933 was revised by ITU-T Study Group 11 (1993-1996) and was approved under the WTSC Resolution No. 1 procedure on the 17th of October 1995.

NOTE

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

CONTENTS

Page

SUMMARY

This Recommendation defines the operation of the Digital subscriber Signalling System No. 1 (DSS 1) for the frame mode basic call and on-demand frame mode switched virtual connections at the T_B or at the coincident S_B and T_B reference point of the user-to-network Interface of the Integrated Services Digital Network (ISDN).

It provides as Annex A signalling procedures for frame mode permanent virtual connection status monitoring, which have been enhanced in this revised version together with the corresponding Protocol Implementation Conformance Statements (PICS) proforma, as a new Annex D.

It also includes a description of means to provide OSI connection oriented network services over Switched Virtual Connections in Annex C and provides a multiprotocol encapsulation scheme for use over frame mode virtual connections, in a new Annex E.

Recommendation Q.933

INTEGRATED SERVICES DIGITAL NETWORK (ISDN) DIGITAL SUBSCRIBER SIGNALLING SYSTEM NO. 1 (DSS 1) – SIGNALLING SPECIFICATIONS FOR FRAME MODE SWITCHED AND PERMANENT VIRTUAL CONNECTION CONTROL AND STATUS MONITORING

(Helsinki, 1993; revised in 1995)

1 Purpose, scope and structure

1.1 Purpose

This Recommendation specifies the procedures for the establishing, maintaining, and clearing of Frame Mode (Frame Relaying or Frame Switching) connections at the User-network interface. These procedures are defined in terms of messages and procedures at the S/T (see Note) reference point for B-channel, and D-channel frame mode connection to a Frame Handler (FH) and Remote Frame Handler (RFH). These messages and procedures are applicable to both basic-rate and primary-rate interfaces. They are generally aligned with those defined in Recommendation Q.931, (1992).

NOTE – The notation S/T indicates S and T, or, S or T reference point.

1.2 Scope

The scope of this Recommendation covers the following procedures at the S/T reference point:

1) circuit-switched access to a remote frame handler (case A) by establishing bearer channel (B or H) associated frame mode connections. In this case, the frame mode network handler is provided using in-channel signalling (see Figure 1-1); or

2) access to the frame mode virtual circuit service on the local ISDN (case B) by establishing a frame mode connection. This connection may be initiated by the user or the ISDN. Both bearer and D-channels may be used in this case (see Figure 1-2).

1.3 Structure

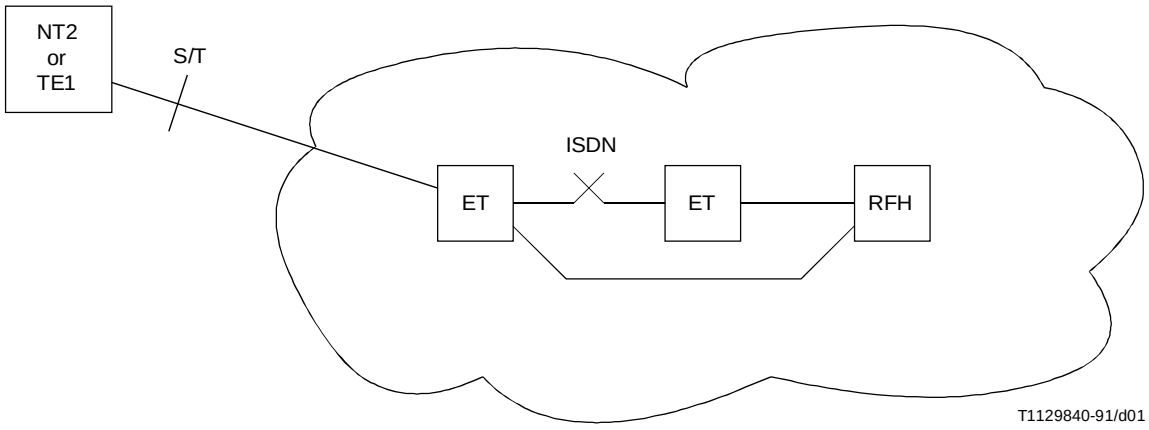
This Recommendation is structured in the same way as Recommendation Q.931. Whenever differences exist in procedures, messages and/or information elements, these are clearly pointed out and fully specified. Information elements of Recommendation Q.931 which are directly applicable to frame mode calls, but require no enhancements for frame mode calls, are handled by direct reference to Recommendation Q.931. This is done in order to avoid unnecessary duplication.

Clause 1 describes the purpose, scope and structure of this Recommendation. Clause 2 provides an overview of frame mode call control and defines call control states. Clause 3 specifies the messages and clause 4 specifies general message format and information coding. Clause 5 specifies the procedures for the establishing, maintaining, and clearing of frame mode connections at the S/T reference point.

2 Overview of frame mode connection control

In this Recommendation, the terms “incoming” and “outgoing” are used to describe the frame mode call as viewed by the user side of the interface.

This clause defines the frame mode call control states that individual calls may have. These definitions do not apply to the state of the interface itself, any attached equipment, the D-channel or the logical links used for signalling on the D-channel. Because several frame mode calls may exist simultaneously at a user-network interface, and each call may be in a different state, the state of the interface itself cannot be unambiguously defined.



RFH Remote Frame Handler
ET Exchange Termination
Step 1 Circuit mode bearer connection establishment between TE1/NT2 and RFH using Q.931 procedures
Step 2 In-channel Q.933 procedures for establishment of frame mode bearer connection

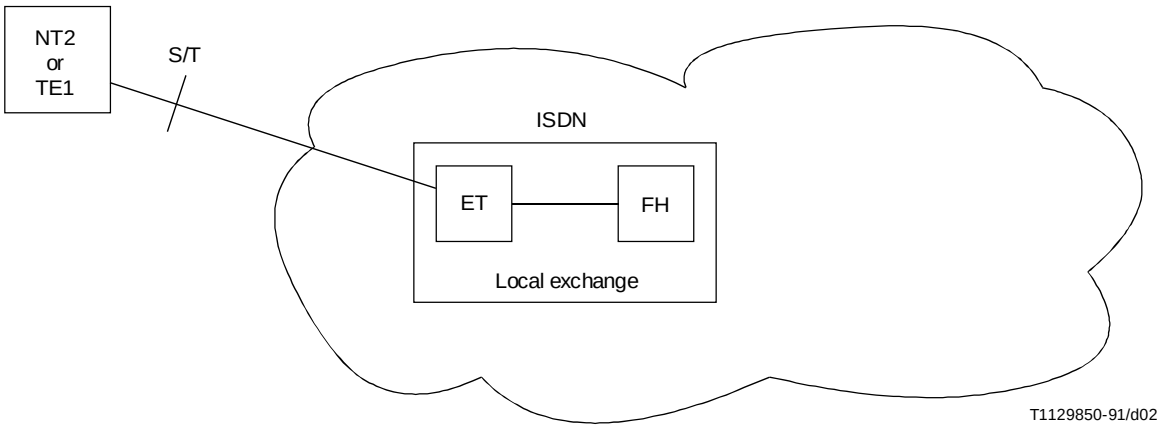
NOTES

1 Step 1 is not required if a semi-permanent connection exists between TE1/NT2 and RFH.

2 The RFH may reside outside the ISDN.

FIGURE 1-1/Q.933

Case A: 2 step frame mode call establishment



FH Frame Handler
Single step Frame mode bearer connection establishment using Q.933 procedures (D-channel)

NOTES

1 Either a bearer channel or D-channel may be used.

2 The location of the FH function could be remote, but some FH functions are needed in the local exchange for the support of frame mode bearer service over the D-channel.

FIGURE 1-2/Q.933

Case B: Integrated access

Detailed descriptions of the procedures for frame mode call control are given in clause 5 in terms of:

a) the sequence of messages defined in clause 3 which are transferred across the user network interface; and

b) the information processing and actions that take place at the user side and the network side.

When differences exist between frame relaying and frame switching bearer services, the differences are explicitly noted.

Throughout this Recommendation, references are made to B-channel. For services using H-channels, the references to B-channels should be taken to refer to the appropriate H-channel.

2.1 Frame mode calls

This subclause defines the call control states for frame mode calls. The procedures for call control are given in clause 5.

The term "call" in this subclause refers to "frame mode call".

2.1.1 Call states at the user side of the interface

The states which may exist on the user side of the user-network interface are defined in this subclause.

2.1.1.1 Null (UO)

No call exists.

2.1.1.2 Call Initiated (U1)

This state exists for an outgoing call, when the user requests call establishment from the network.

2.1.1.3 Outgoing Call Proceeding (U3)

This state exists for an outgoing call when the user has received acknowledgement that the network has received all call information necessary to effect call establishment.

2.1.1.4 Call Delivered (U4)

This state exists for an outgoing call when the calling user has received an indication that remote user alerting has been initiated.

2.1.1.5 Call Present (U6)

This state exists for an incoming call when the user has received a call establishment request but has not yet responded.

2.1.1.6 Call Received (U7)

This state exists for an incoming call when the user has indicated alerting but has not yet answered.

2.1.1.7 Connect Request (U8)

This state exists for an incoming call when the user has answered the call and is waiting to be awarded the call.

2.1.1.8 Incoming Call Proceeding (U9)

This state exists for an incoming call when the user has sent acknowledgement that the user has received all call information necessary to effect call establishment.

2.1.1.9 Active (U10)

This state exists for an incoming call when the user has received an acknowledgement from the network that the user has been awarded the call. This state exists for an outgoing call when the user has received an indication that the remote user has answered the call.

2.1.1.10 Disconnect Request (U11)

This state exists when the user has requested the network to clear the end-to-end connection (if any) and is waiting for a response.

2.1.1.11 Disconnect Indication (U12)

This state exists when the user has received an invitation to disconnect because the network has disconnected the end-to-end connection (if any).

2.1.1.12 Release Request (U19)

This state exists when the user has requested the network to release and is waiting for a response.

2.1.2 Call states at the network side of the interface

The call states that may exist on the network side of the user-network interface are defined in this subclause.

2.1.2.1 Null (NO)

No call exists.

2.1.2.2 Call Initiated (N1)

This state exists for an outgoing call when the network has received a call establishment request but has not yet responded.

2.1.2.3 Outgoing Call Proceeding (N3)

This state exists for an outgoing call when the network has sent acknowledgement that the network has received all call information necessary to effect call establishment.

2.1.2.4 Call Delivered (N4)

This state exists for an outgoing call when the network has indicated that remote user alerting has been initiated.

2.1.2.5 Call Present (N6)

This state exists for an incoming call when the network has sent a call establishment request but not yet received a satisfactory response.

2.1.2.6 Call Received (N7)

This state exists for an incoming call when the network has received an indication that the user is alerting but has not yet received an answer.

2.1.2.7 Connect Request (N8)

This state exists for an incoming call when the network has received an answer but the network has not yet awarded the call.

2.1.2.8 Incoming Call Proceeding (N9)

This state exists for an incoming call when the network has received acknowledgement that the user has received all call information necessary to effect call establishment.

2.1.2.9 Active (N10)

This state exists for an incoming call when the network has awarded the call to the called user. This state exists for an outgoing call when the network has indicated that the remote user has answered the call.

2.1.2.10 Disconnect Request (N11)

This state exists when the network has received a request from the user to clear the end-to-end connection (if any).

2.1.2.11 Disconnect Indication (N12)

This state exists when the network has disconnected the end-to-end connection (if any) and has sent an invitation to disconnect the user-network connection.

2.1.2.12 Release Request (N19)

This state exists when the network has requested the user to release and is waiting for a response.

2.1.2.13 Call Abort (N22)

This state exists for an incoming call for the point-to-multipoint configuration when the call is being cleared before any user has been awarded the call.

3 Message functional definitions and content

This clause provides an overview of the message structure, which highlights the functional definition and information content (i.e. semantics) 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 in the originating or terminating access;

   b) access significance, i.e. relevant in the originating and terminating access, but not in the network;

   c) dual significance, i.e. relevant in either the originating or terminating access and in the network; or

   d) global significance, i.e. relevant in the originating and terminating access and in the network.

2) A table listing the codeset 0 information elements in the order of their appearance in the message (same relative order by all message types). For each information element, the table indicates:

   a) the clause or subclause of this Recommendation describing the information element;

   b) the direction in which it may be sent; i.e. user to network ("u → n"), network to user ("n → u"), or both;

      NOTE 1 – The user-network terminology in this clause refers to the TE – ET, TE – NT2 and NT2 – ET interface structures.

   c) whether inclusion is mandatory ("M") or optional ("O"), with a reference to notes explaining the circumstances under which the information element shall be included; and

   d) the length of the information element (or permissible range of lengths), in octets, where "*" denotes an undefined maximum length, which may be network or service dependent.

      NOTE 2 – All messages may contain information elements from codesets 5, 6 and 7 and corresponding locking shift information element which comply with the coding rules specified in 4.5.2 – 4.5.3. None of these information elements, however, are listed in this clause.

3.1 Messages for frame mode connection control

Table 3-1 summarizes the messages for frame mode connection control. These messages are a subset of the messages defined and specified in Recommendation Q.931. The scope and the significance of the messages used in this Recommendation are as defined in Recommendation Q.931; wherever differences and/or new information elements are present, these are clearly pointed out and fully specified.

TABLE 3-1/Q.933

Messages for frame mode connection control

Message	Reference	Message	Reference
Call establishment messages:		*Call clearing messages:*	
ALERTING	3.1.1	DISCONNECT	3.1.5
CALL PROCEEDING	3.1.2	RELEASE	3.1.7
CONNECT	3.1.3	RELEASE COMPLETE	3.1.8
CONNECT ACKNOWLEDGE	3.1.4		
PROGRESS	3.1.6	*Miscellaneous messages:*	
SETUP	3.1.9	STATUS	3.1.10
		STATUS ENQUIRY	3.1.11

3.1.1 Alerting

This message is sent by the called user to the network and by the network to the calling user to indicate that called user alerting has been initiated. See Table 3-2.

TABLE 3-2/Q.933

ALERTING message content

Message type: ALERTING — Direction: both
Significance: global

Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	Both	M	1
Call reference	4.3	Both	M	2-*
Message type	4.4	Both	M	1
Channel identification	4.5.12	Both	O (Note 1)	2-*
Data link connection identifier	4.5.15	Both	O (Note 2)	2-6
Progress indicator	4.5.24	Both	O (Note 3)	2-4
Display	4.5.16	n → u	O (Note 4)	(Note 5)
User-user	4.5.28	Both	O (Note 6)	(Note 7)

NOTES

1 Mandatory if this message is the first message in response to SETUP for case B.

2 Mandatory if this message is the first response to SETUP message.

3 Included in the event of interworking within a private network.

4 Included if the network provides information that can be presented to the user.

5 The minimum length is 2 octets; the maximum length is 82 octets.

6 Included in the user-to-network direction when an incoming call is offered over a point-point data link and the called user wants to return user information to the calling user. Included in the network-to-user direction if the called user included user information in the ALERTING message.

7 The minimum length is 2 octets; the standard default maximum length is 131 octets.

3.1.2 Call proceeding

This message is sent by the called user to the network or by network to the calling user to indicate that the requested call establishment has been initiated and no more call establishment information will be accepted. See Table 3-3.

TABLE 3-3/Q.933

CALL PROCEEDING message content

Message type: CALL PROCEEDING — Direction: both
Significance: local

Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	Both	M	1
Call reference	4.3	Both	M	2-*
Message type	4.4	Both	M	1
Channel identification	4.5.12	Both	O (Note 1)	2-*
Data link connection identifier	4.5.15	Both	O (Note 2)	2-6
Progress indicator	4.5.24	Both	O (Note 3)	2-4
Display	4.5.16	n → u	O (Note 4)	(Note 5)

NOTES

1 Mandatory if this message is the first message in response to SETUP.

2 Mandatory if this message is the first response to SETUP message.

3 Included in the event of interworking within a private network.

4 Included if the network provides information that can be presented to the user.

5 The minimum length is 2 octets; the maximum length is 82 octets.

3.1.3 Connect

This message is sent by the called user to the network and by the network to the calling user to indicate call acceptance by the called user. See Table 3-4.

3.1.4 Connect acknowledge

This message is sent by the network to the called user to indicate the user has been awarded the call. It may also be sent by the calling user to the network to allow symmetrical call control procedures. See Table 3-5.

3.1.5 Disconnect

This message is sent by the user to request the network to clear the frame mode connection or is sent by the network to indicate that the frame mode connection is cleared. See Table 3-6.

3.1.6 Progress

This message is sent by the user or the network to indicate the progress of a call in the event of interworking. See Table 3-7.

3.1.7 Release

This message is sent by the user or the network to indicate that the equipment sending the message has disconnected the frame mode connection and intends to release the data link connection identifier (if any) and the call reference, and that the receiving equipment should release the data link connection identifier and prepare to release the call reference after sending RELEASE COMPLETE. See Table 3-8.

In case B, the bearer channel will be released when releasing the last frame mode connection.

TABLE 3-4/Q.933

CONNECT message content

Message type: CONNECT — Direction: both
Significance: global

Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	Both	M	1
Call reference	4.3	Both	M	2-*
Message type	4.4	Both	M	1
Channel identification	4.5.12	Both	O (Note 1)	2-*
Data link connection identifier	4.5.15	Both	O (Note 2)	2-6
Progress indicator	4.5.24	Both	O (Note 3)	2-4
Display	4.5.16	n → u	O (Note 4)	(Note 5)
End-to-end transit delay	4.5.17	Both	O (Note 6)	2-11
Packet layer binary parameters	4.5.23	Both	O (Note 7)	2-3
Link layer core parameters	4.5.19	Both	O (Note 8)	2-27
Link layer protocol parameters	4.5.20	Both	O (Note 9)	2-9
Connected number	4.5.13	Both	O (Note 10)	2-*
Connected sub-address	4.5.14	Both	O (Note 10)	2-23
X.213 priority	4.5.29	Both	O (Note 11)	2-8
Low layer compatibility	4.5.21	Both	O (Note 12)	2-16
User-user	4.5.28	Both	O (Note 13)	(Note 14)

NOTES

1 Mandatory in case B, if this message is the first message in response to SETUP.

2 Mandatory if this message is the first response to SETUP message.

3 Included in the event of interworking within a private network.

4 Included if the network provides information that can be presented to the user.

5 The minimum length is 2 octets; the maximum length is 82 octets.

6 Included in the user-to-network direction when the responding user received the End-to-end transit delay information element in the SETUP message. Included in the network-to-user direction if the responding user included in the CONNECT message.

7 Included in the user-to-network direction when the responding user received the packet layer binary parameter information element in the SETUP message. Included in the network-to-user direction if the responding user included in the CONNECT message.

8 Included in the user-to-network direction when the responding user received the Link layer core parameters information element in the SETUP message. Included in the network-to-user direction if the responding user included in the CONNECT message.

9 In case of Frame Relaying, it is included if the responding user wants to return link layer protocol parameters to the calling user. It is carried transparently by the network.

In case of Frame Switching, it is included in the network-to-user direction when the network wants to indicate the agreed link layer protocol parameters to the calling user. Included in the user-to-network direction when responding user wants to indicate the agreed link layer protocol parameter values to the network. In this case these parameters have only local significance.

10 Optionally included by the user to indicate the connected user to the calling user, according to OSI network service requirements.

11 Included in the user-to-network direction when the responding user received the X.213 priority information element in the SETUP message. Included in the network-to-user direction if the responding user included in the CONNECT message.

12 Included in the user-to-network direction when the answering user wants to return low layer compatibility information to the calling user. Included in the network-to-user direction if the user awarded the call included a Low layer compatibility information element in the CONNECT message. Optionally included for low layer compatibility negotiation to the calling user (see Annex J/Q.931).

13 Included in the user-to-network direction when the answering user wants to return user information to the calling user. Included in the network-to-user direction if the user awarded the call included a User-user information element in the CONNECT message.

14 The minimum length is 2 octets; the standard default maximum length is 131 octets.

TABLE 3-5/Q.933

CONNECT ACKNOWLEDGE message content

Message type: CONNECT ACKNOWLEDGE Significance: local		Direction: both		
Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	Both	M	1
Call reference	4.3	Both	M	2-*
Message type	4.4	Both	M	1
Display	4.5.16	n → u	O (Note 1)	(Note 2)

NOTES

1 Included if the network provides information that can be presented to the user.

2 The minimum length is 2 octets; the maximum length is 82 octets.

TABLE 3-6/Q.933

DISCONNECT message content

Message type: DISCONNECT Significance: global		Direction: both		
Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	Both	M	1
Call reference	4.3	Both	M	2-*
Message type	4.4	Both	M	1
Cause	4.5.11	Both	M	4-32
Display	4.5.16	n → u	O (Note 1)	(Note 2)
Connected number	4.5.13	Both	O (Note 3)	2-*
Connected sub-address	4.5.14	Both	O (Note 3)	2-23
User-user	4.5.28	Both	O (Note 4)	(Note 5)

NOTES

1 Included if the network provides information that can be presented to the user.

2 The minimum length is 2 octets; the maximum length is 82 octets.

3 Optionally included by the user to indicate the connected user to the calling user, according to OSI network service requirements.

4 Included when the user initiates call clearing and wants to pass user information to the remote user at call clearing time.

5 The minimum length is 2 octets; the standard default maximum length is 131 octets.

TABLE 3-7/Q.933

PROGRESS message content

Message type: PROGRESS		Direction: both		
Significance: global				
Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	Both	M	1
Call reference	4.3	Both	M	2-*
Message type	4.4	Both	M	1
Cause	4.5.11	Both	O (Note 1)	2-32
Progress indicator	4.5.24	Both	M	4
Display	4.5.16	n → u	O (Note 2)	(Note 3)

NOTES

1 Included by the user or the network to provide additional information concerning the interworking.

2 Included if the network provides information that can be presented to the user.

3 The minimum length is 2 octets; the maximum length is 82 octets.

TABLE 3-8/Q.933

RELEASE message content

Message type: RELEASE		Direction: both		
Significance: local (Note 1)				
Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	Both	M	1
Call reference	4.3	Both	M	2-*
Message type	4.4	Both	M	1
Cause	4.5.11	Both	O (Note 2)	2-32
Display	4.5.16	n → u	O (Note 3)	(Note 4)
Connected number	4.5.13	Both	O (Note 5)	2-*
Connected	4.5.14	Both	O (Note 5)	2-23
User-user	4.5.28	Both	O (Note 6)	(Note 7)

NOTES

1 This message has local significance; however, it may carry information of global significance when used as the first call clearing message.

2 Mandatory in the first call clearing message, including when the RELEASE message is sent as a result of an error handling condition.

3 Included if the network provides information that can be presented to the user.

4 The minimum length is 2 octets: the maximum length is 82 octets.

5 Optionally included by the user to indicate the responding user to the calling user according to OSI network service requirements, if RELEASE is the first call clearing message.

6 Included when the RELEASE message is the first call clearing message, and the user initiates call clearing and wants to pass information to the remote user at the call clearing time.

7 The minimum length is 2 octets; the standard default maximum length is 131 octets.

3.1.8 Release complete

This message is sent by the user or the network to indicate that the equipment sending the message has released the call reference and, if appropriate, the channel. The channel, if released, is available for reuse. The receiving equipment shall release the call reference. See Table 3-9.

TABLE 3-9/Q.933

RELEASE COMPLETE message content

Message type: RELEASE COMPLETE Significance: local (Note 1)		Direction: both		
Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	Both	M	1
Call reference	4.3	Both	M	2-*
Message type	4.4	Both	M	1
Cause	4.5.11	Both	O (Note 2)	2-32
Display	4.5.16	n → u	O (Note 3)	(Note 4)
Connected number	4.5.13	Both	O (Note 5)	2-*
Connected sub-address	4.5.14	Both	O (Note 5)	2-23
User-user	4.5.28	Both	O (Note 6)	(Note 7)

NOTES

1 This message has local significance; however, it may carry information of global significance when used as the first call clearing message.

2 Mandatory in the first call clearing message, including when the RELEASE COMPLETE message is sent as a result of an error handling condition.

3 Included if the network provides information that can be presented to the user.

4 The minimum length is 2 octets: the maximum length is 82 octets.

5 Optionally included by the user to indicate the responding user to the calling user according to OSI network service requirements, if RELEASE COMPLETE is the first call clearing message.

6 Included when the RELEASE COMPLETE message is the first call clearing message, and the user initiates call clearing and wants to pass information to the remote user at the call clearing time.

7 The minimum length is 2 octets; the standard default maximum length is 131 octets.

3.1.9 Setup

This message is sent by the calling user to the network and by the network to the called user to initiate frame mode call establishment. See Table 3-10.

3.1.10 Status

This message is sent by the user or the network in response to a STATUS ENQUIRY message or at any time during a call to report certain error conditions as listed in 5.8/Q.931. See also Table 3-11.

3.1.11 Status enquiry

This message is sent by the user or the network at any time to solicit a STATUS message from the peer layer 3 entity. Sending a STATUS message in response to a STATUS ENQUIRY message is mandatory. See Table 3-12.

3.2 Messages used with global call reference

See 3.4/Q.931.

TABLE 3-10/Q.933

SETUP message content

Message type: SETUP Significance: global		Direction: both		
Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	Both	M	1
Call reference	4.3	Both	M	2-*
Message type	4.4	Both	M	1
Bearer capability	4.5.5	Both	M	4-5
Channel identification	4.5.12	Both	O (Note 1)	2-*
Data link connection identifier	4.5.15	Both	O (Note 2)	2-6
Progress indicator	4.5.24	Both	O (Note 3)	2-4
Network-specific facilities	4.5.22	Both	O (Note 4)	2-*
Display	4.5.16	n → u	O (Note 5)	(Note 6)
End-to-end transit delay	4.5.17	Both	O (Note 7)	2-11
Packet layer binary parameters	4.5.23	Both	O (Note 8)	2-3
Link layer core parameters	4.5.19	Both	O (Note 9)	2-27
Link layer protocol parameters	4.5.20	Both	O (Note 10)	2-9
X.213 priority	4.5.29	Both	O (Note 11)	2-8
Calling party number	4.5.9	Both	O (Note 12)	2-*
Calling party sub-address	4.5.10	Both	O (Note 13)	2-23
Called party number	4.5.7	Both	O (Note 14)	2-*
Called party sub-address	4.5.8	Both	O (Note 15)	2-23
Transit network selection	4.5.27	u → n	O (Note 16)	2-*
Repeat indicator	4.5.25	Both	O (Note 17)	1
Low layer compatibility	4.5.21	Both	O (Note 18)	2-16
High layer compatibility	4.5.18	Both	O (Note 19)	2-4
User-user	4.5.28	Both	O (Note 20)	(Note 21)

NOTES

1 Mandatory in the network-to-user direction. Included in the user-to-network direction when the user wants to indicate a channel. If not included, its absence is interpreted as “any channel acceptable”. No channel negotiation is allowed in case A.

2 Mandatory in the network-to-user direction. Included in the user-to-network direction when the user wants to indicate the DLCI value to be used for the frame mode call.

3 Included in the event of interworking within a private network.

4 Included by the calling user or the network to indicate network specific facilities information (see Annex E/Q.931).

5 Included if the network provides information that can be presented to the user.

6 The minimum length is 2 octets; the maximum length is 82 octets.

7 May be omitted in the user-to-network direction, if the calling user accepts default values for this Quality of Service parameter. Always included in the network-to-user direction to indicate cumulative end-to-end transit delay to the called user.

8 Included in the user-to-network direction when the calling user wants to provide OSI network service requirements. Included in the network-to-user direction if the calling user included a packet layer binary parameter information element in the SETUP message.

9 Included in the user-to-network direction when the calling user wants to indicate the proposed link layer core parameter values to the network. Always included in the network-to-user direction to indicate the proposed link layer core parameter values to the called user.

If the Link layer core parameter information element is not present in the user-to-network direction the default values will be assumed, and the network will negotiate link layer core parameters with the called user based on the calling user default values.

TABLE 3-10/Q.933 *(concluded)*

SETUP message content

NOTES

10 In case of Frame Relaying, it is included if the calling user wants to indicate link layer protocol parameters to the called user. It is carried transparently by the network.

In case of Frame Switching, it is included in the user-to-network direction when the calling user wants to indicate the proposed link layer protocol parameter values to the network. Included in the network-to-user direction when the network wants to indicate the proposed link layer protocol parameter values to the called user. In this case these parameters have only local significance.

11 Included in the user-to-network direction when the calling user wants to provide OSI network service requirements. Included in the network-to-user direction if the calling user included X.213 priority information element in the SETUP message.

12 May be included by the calling user or the network to identify the calling user.

13 Included in the user-to-network direction when the calling user wants to indicate the calling party sub-address. Included in the network-to-user direction if the calling user included a Calling party sub-address information element in the SETUP message.

14 The Called party number information element is included by the user to convey called party number information to the network. The Called party number information element is included by the network when called party number information is conveyed to the user.

15 Included in the user-to-network direction when the calling user wants to indicate the called party sub-address. Included in the network-to-user direction if the calling user included a Called party sub-address information element in the SETUP message.

16 Included by the calling user to select a particular transit network (see Annex C/Q.931).

17 The Repeat indicator information element is included immediately before the first Low layer compatibility information element when the low layer compatibility negotiation procedure is used (see Annex J/Q.931).

18 Included in the user-to-network direction when the calling user wants to pass low layer compatibility information to the called user. Included in the network-to-user direction if the calling user included a Low layer compatibility information element in the SETUP message.

19 Included in the user-to-network direction when the calling user wants to pass high layer compatibility information to the called user. Included in the network-to-user direction if the calling user included a High layer compatibility information element in the SETUP message.

20 Included in the user-to-network direction when the calling user wants to pass user information to the called user. Included in the network-to-user direction if the calling user included User-user information element in the SETUP message.

21 The minimum length is 2 octets; the standard default maximum length is 131 octets.

TABLE 3-11/Q.933

STATUS message content

Message type: STATUS — Direction: both
Significance: local

Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	Both	M	1
Call reference	4.3	Both	M	2-*
Message type	4.4	Both	M	1
Cause	4.5.11	Both	M	4-32
Call state	4.5.6	Both	M	3
Display	4.5.16	n → u	O (Note 1)	(Note 2)

NOTES

1 Included if the network provides information that can be presented to the user.

2 The minimum length is 2 octets; the maximum length is 82 octets.

TABLE 3-12/Q.933

STATUS ENQUIRY message content

Message type: STATUS ENQUIRY — Direction: both
Significance: local

Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	Both	M	1
Call reference	4.3	Both	M	2-*
Message type	4.4	Both	M	1
Display	4.5.16	n → u	O (Note 1)	(Note 2)

NOTES

1 Included if the network provides information that can be presented to the user.

2 The minimum length is 2 octets; the maximum length is 82 octets.

4 General message format and information element coding

The figures and text in this clause describe message contents. Within each octet, the bit designated “bit 1” is transmitted first, followed by bits 2, 3, 4, etc. Similarly, the octet shown at the top of each figure is sent first.

4.1 Overview

See 4.1/Q.931.

4.2 Protocol discriminator

See 4.2/Q.931.

4.3 Call reference

See 4.3/Q.931.

4.4 Message type

The purpose of the message type is to identify the function of the message being sent.

The message type is the third part of every message. Bit 8 is reserved for possible future use as an extension bit. See Figure 4-1 and Table 4-1.

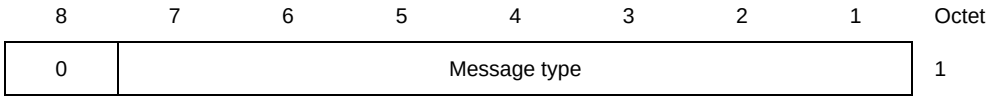


FIGURE 4-1/Q.933

Message type

TABLE 4-1/Q.933

Message types

Bits 8765 4321	
0000 0000	Escape to nationally specified message types; see Note.
000- ----	*Call establishment messages:*
0 0001	ALERTING
0 0010	CALL PROCEEDING
0 0111	CONNECT
0 1111	CONNECT ACKNOWLEDGE
0 0011	PROGRESS
0 0101	SETUP
010- ----	*Call clearing messages:*
0 0101	DISCONNECT
0 1101	RELEASE
1 1010	RELEASE COMPLETE
011- ----	*Miscellaneous messages:*
0 0000	SEGMENT
1 1101	STATUS
1 0101	STATUS ENQUIRY

NOTE – When used, the message type is defined in the following octet(s), according to national specification. The extension mechanism (bit 8 of the message type) is independent of the escape mechanism for the message.

4.5 Other information elements

4.5.1 Coding rules

See 4.5.1/Q.931 except for information element identifier coding table. See Table 4-2 for information element identifier coding.

4.5.2 Extensions of codesets

See 4.5.2/Q.931.

4.5.3 Locking shift procedure

See 4.5.3/Q.931.

4.5.4 Non-locking shift procedures

See 4.5.4/Q.931.

4.5.5 Bearer capability

The purpose of the Bearer capability information element is to indicate a requested I.233 bearer service to be provided by the network. (See Figure 4-2 and Table 4-3.) It contains only information which may be used by the network (see Annex I/Q.931). The use of the bearer capability information element in relation to compatibility checking is described in Annex B/Q.931.

No default bearer capability may be assumed by the absence of this information element. The maximum length of this information element is 5 octets.

TABLE 4-2/Q.933

Information element identifier coding

8765 4321		Reference	Max length (octets) (Note 1)
1 :::: ----	*Single octet information elements*:		
000 ----	reserved		
001 ----	Shift (Note 2)	4.5.3	1
101 ----	Repeat indicator	4.5.25	1
0 ::: ::::	*Variable length information elements:*		
000 0000	Segmented message	4.5.26	
000 0100	Bearer capability	4.5.5	5
000 1000	Cause (Note 2)	4.5.11	32
001 0100	Call state	4.5.6	3
001 1000	Channel identification	4.5.12	(Note 4)
001 1001	Data link connection identifier (Note 7)	4.5.15	6
001 1110	Progress indicator (Note 2)	4.5.24	4
010 0000	Network specific facilities (Note 2)	4.5.22	(Note 4)
010 1000	Display	4.5.16	82
100 0010	End-to-end transit delay	4.5.17	11
100 0100	Packet layer binary parameters (Note 7)	4.5.23	3
100 1000	Link layer core parameters (Note 7)	4.5.19	27
100 1001	Link layer protocol parameters (Note 7)	4.5.20	9
100 1100	Connected number	4.5.13	(Note 4)
100 1101	Connected sub-address	4.5.14	23
101 0000	X.213 priority (Note 7)	4.5.29	8
101 0001	Report type (Note 7)	A.3.1	3
101 0011	Link integrity verification (Note 7)	A.3.2	4
101 0111	PVC status (Notes 2 and 7)	A.3.3	5
110 1100	Calling party number	4.5.9	(Note 4)
110 1101	Calling party sub-address	4.5.10	23
111 0000	Called party number	4.5.7	(Note 4)
111 0001	Called party sub-address	4.5.8	23
111 1000	Transit network selection (Note 2)	4.5.27	(Note 4)
111 1100	Low layer compatibility (Note 6)	4.5.21	14
111 1101	High layer compatibility	4.5.18	4
111 1110	User-user	4.5.28	131
111 1111	Escape for extension (Note 3)		
	All other values are reserved (Note 5)		

NOTES

1 The length limits described for the variable length information elements below take into account only the present CCITT standardized coding values.

2 This information element may be repeated.

3 This escape mechanism is limited to codesets 5, 6 and 7 (see 4.5.2). When the escape for extension is used, the information element identifier is contained in octet-group 3 and the content of the information element follows in the subsequent octets.

4 The maximum length is network dependent.

5 The reserved values with bits 5 to 8 coded "0000" are for future information elements for which comprehension by the receiver is required (see 5.8.7.1/Q.931).

6 This information element may be repeated in conjunction with the Repeat indicator information element.

7 Information elements defined in this Recommendation; not present in Recommendation Q.931.

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

NOTES

1 Octet 5 is omitted. The configuration is assumed to be point-to-point; and the method of establishment is on demand.

2 Octet 6 is used to select between Frame Relaying and Frame Switching bearer services.

FIGURE 4-2/Q.933

Bearer capability information element

TABLE 4-3/Q.933

Bearer capability information element

Coding standard (octet 3)

Bits

7 6

0 0 CCITT standardized coding as described below

Information transfer capability (octet 3)

Bits

5 4 3 2 1

0 1 0 0 0 Unrestricted digital information

All other values are reserved

Transfer mode (octet 4)

Bits

7 6

0 1 Frame mode

All other values are reserved

User information layer 2 protocol (octet 6)

Bits

5 4 3 2 1

0 1 1 1 0 Recommendation Q.922

0 1 1 1 1 Core aspects of frame mode (Annex A/Q.922)

All other values are reserved

4.5.6 Call state

See 4.5.7/Q.931. The relevant states are described in 2.1.

4.5.7 Called party number

See 4.5.8/Q.931 with the following conditions: type of number (octet 5) equal to “unknown” is only allowed with the addressing/numbering plan identification (octet 5) equal to “unknown”. Type of number other than “unknown” are not allowed with “unknown”. Addressing/numbering identification and conversely addressing/numbering identification other than “unknown” are not allowed with “unknown” type of number.”

4.5.8 Called party sub-address

See 4.5.9/Q.931.

4.5.9 Calling party number

See 4.5.10/Q.931 with the following conditions: type of number (octet 5) equal to “unknown” is only allowed with the addressing/numbering plan identification (octet 5) equal to “unknown”. Type of number other than “unknown” are not allowed with “unknown” addressing/numbering identification and conversely addressing/numbering identification other than “unknown” are not allowed with “unknown” type of number.

4.5.10 Calling party sub-address

See 4.5.11/Q.931.

4.5.11 Cause

See 4.5.12/Q.931.

4.5.12 Channel identification

See 4.5.13/Q.951.

4.5.13 Connected number

See 5.4.1/Q.951.

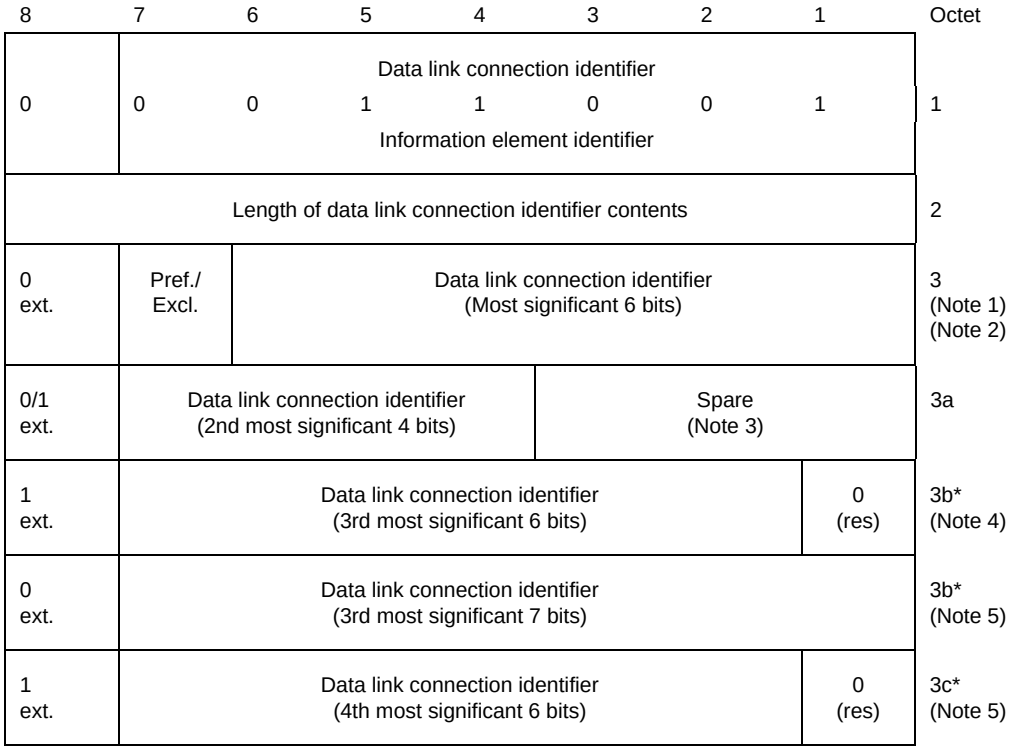
4.5.14 Connected sub-address

See 5.4.2/Q.951.

4.5.15 Data link connection identifier

The Data link connection identifier information element has two purposes: it identifies the Data link connection identifier selection option (i.e. preferred or exclusive) and the Data link connection identifier requested or assigned. This information element is present in the SETUP message, and in the first response to the SETUP message. See Figure 4-3 and Table 4-4.

The maximum length of this information element is 6 octets.



NOTES

1 The standard default length of the DLCI is two octets. Optionally, some networks may also offer a three or four octet DLCI, in which case the length of the DLCI is established by subscription.

2 Bit 6 of octet 3 is the most significant bit in Data link connection identifier.

3 These bits are used for congestion control in the Frame Relaying bearer service for data transfer phase (see Annex A/Q.922).

4 This octet shall be included only when subscription allows a three octet DLCI (16 bits).

5 These octets shall both be included only when subscription allows a four octet DLCI (23 bits).

FIGURE 4-3/Q.933

Data link connection identifier information element

TABLE 4-4/Q.933

Data link connection identifier information element

Preferred / Exclusive (octet 3)

Bit

7

0 Indicated logical link identifier is preferred

1 Exclusive; only the indicated logical link identifier is acceptable

Data link connection identifier (octet 3 and 3a, optionally 3b and 3c)

Data link connection identifier is coded in binary

4.5.16 Display

See 4.5.16/Q.931.

4.5.17 End-to-end transit delay

The purpose of the End-to-end transit delay information element is to request and indicate the nominal maximum permissible transit delay applicable on a per call basis to the frame mode call.

Transit delay is the end-to-end one-way transit delay for frame mode data transfer phase, on the user plane, between calling user and called user. It includes the total processing time in the end user systems (e.g. processing time plus any additional transit delays). It contains three values: cumulative, requested, and maximum end-to-end delays.

The cumulative delay is the highest delay that should be experienced by 95% of the frames of the requested maximum frame size. 95% of the frames for the frame mode call will transit the frame mode user plane at or below this transit delay. The cumulative transit delay is calculated using the maximum frame size. The value encoded in the cumulative transit delay field in the SETUP message sent from the network to the called user should exceed the value encoded in the SETUP message received from the calling user by an amount equal to the delay expected within the network for frames of that call sent during the frame mode call data transfer phase. The requested and maximum delay values are used to determine if the call can be set up to meet the end user specified delay values.

The CONNECT message contains the final end-to-end accumulated transit delay value. If the agreed maximum frame size is less than that requested by the calling user, the actual delay may be less than the calculated value (e.g. some portions of the delay are calculated on a higher maximum frame size).

NOTE - In some scenarios involving interworking between frame mode networks and other networks, this information element may not convey sufficient information to convey simultaneously end-to-end transit delay between OSI network service users and to provide for efficient setting of data link layer parameters. Additional formats may be needed to support the full range of scenarios.

The maximum length of this information element is 11 octets.

For coding, see 4.6.2/Q.931.

4.5.18 High layer compatibility

See 4.5.17/Q.931.

4.5.19 Link layer core parameters

The purpose of the Link layer parameters information element is to indicate requested core service quality parameter values to be used for the frame mode call. See Figure 4-4 and Table 4-5.

The maximum length of this information element is 27 octets.

4.5.20 Link layer protocol parameters

The purpose of the Link layer protocol parameters information element is to indicate requested layer 2 parameter values for the link layer elements of procedures to be used for the call. See Figure 4-5 and Table 4-6.

The maximum length of this information element is 9 octets.

4.5.21 Low layer compatibility

The purpose of the Low layer compatibility information element is to provide a means which should be used for compatibility checking by an addressed entity (e.g. a remote user or an interworking unit or a high layer function network node addressed by the calling user). The Low layer compatibility information element is transferred transparently by frame mode network between the call originating entity (e.g. the calling user) and the addressed entity. See Annex B/Q.931 and Annex I/Q.931.

If low layer compatibility negotiation is allowed by the network (see Annex J/Q.931), the Low layer compatibility information element is also passed transparently from the addressed entity to the originating entity. See Figure 4-6 and Table 4-7.

The maximum length of this information element is 14 octets.

8	7	6	5	4	3	2	1	Octet
	Link layer core parameters							
0	1	0	0	1	0	0	0	1
	Information element identifier							(Notes 1, 7)
Length of link layer core parameters contents								2
	Maximum Frame Mode Information Field (FMIF) size							3
0 ext.	0	0	0	1	0	0	1	
0 ext.	Outgoing maximum FMIF size							3a
0/1 ext.	Outgoing maximum FMIF size (cont.)							3b
0 ext.	Incoming maximum FMIF size							3c*
1 ext.	Incoming maximum FMIF size (cont.)							3d*
	Throughput							4*
0 ext.	0	0	0	1	0	1	0	(Note 2)
0 ext.	Outgoing magnitude				Outgoing multiplier			4a*
0/1 ext.	Outgoing multiplier (cont.)							4b*
0 ext.	Incoming magnitude				Incoming multiplier			4c*
1 ext.	Incoming multiplier (cont.)							4d*
	Minimum acceptable throughput							5*
0 ext.	0	0	0	1	0	1	1	(Notes 3, 4)
0 ext.	Outgoing magnitude				Outgoing multiplier			5a* (Note 4)
0/1 ext.	Outgoing multiplier (cont.)							5b* (Note 4)
0 ext.	Incoming magnitude				Incoming multiplier			5c* (Note 4)
1 ext.	Incoming multiplier (cont.)							5d* (Note 4)
	Committed burst size							6*
0 ext.	0	0	0	1	1	0	1	(Note 5)
0 ext.	Outgoing committed burst size value							6a*
0/1 ext.	Outgoing committed burst size value (cont.)							6b*
0 ext.	Incoming committed burst size value							6c*
1 ext.	Incoming committed burst size value (cont.)							6d*
	Excess burst size							7*
0 ext.	0	0	0	1	1	1	0	(Note 6)
0 ext.	Outgoing excess burst size value							7a*
0/1 ext.	Outgoing excess burst size value (cont.)							7b*
0 ext.	Incoming excess burst size value							7c*
1 ext.	Incoming excess burst size value (cont.)							7d*
	Committed burst size magnitude							
0 ext.	0	0	1	0	0	0	0	8* (Note 8)
1 ext.	Spare	Incoming Bc magnitude			Outgoing Bc magnitude			8a*
	Excess burst size magnitude							
0 ext.	0	0	1	0	0	0	1	9* (Note 9)
1 ext.	Spare	Incoming Bc magnitude			Outgoing Bc magnitude			9a*

FIGURE 4-4/Q.933

Link layer core parameters information element

NOTES

1 All the parameters are optional and position independent. If certain parameters are not included, the network default value will be used. The term "outgoing" is defined in the direction from calling user to called user. The term "incoming" is defined in the direction from called user to calling user.

2 When octet 4 is present, octet 4a and octet 4b shall also be present. Additionally, octet group 4c and 4d may be included.

3 When octet 5 is present, octet 5a and octet 5b shall also be present. Additionally, octet group 5c and 5d may be included.

4 Included only in the SETUP message.

5 When octet 6 is present, octet 6a and octet 6b shall also be present. Additionally, octet group 6c and 6d may be included.

6 When octet 7 is present, octet 7a and octet 7b shall also be present. Additionally, octet group 7c and 7d may be included.

7 "Throughput" and "Measurement interval (T)" (see Table 4-5, 2 of 2) are defined as "Committed Information Rate (CIR)" and "Committed rate measurement interval (T_C)" in Recommendation I.370, respectively.

8 Octet group 8 is used to indicate the committed burst size magnitude when the value cannot be coded in octet group 6. When the incoming committed burst size field is not included (in octet group 6), the incoming magnitude field has no significance.

9 Octet group 9 is used to indicate the excess burst size magnitude when the value cannot be coded in octet group 7. When the incoming excess burst size field is not included (in octet group 6), the incoming magnitude field has no significance.

4.5.22 Network-specific facilities

See 4.5.21/Q.931.

4.5.23 Packet layer binary parameters

The purpose of the Packet layer binary parameters information element is to include the requested layer 3 parameter values for support of the OSI connection mode network service (CONS) to be used for the call.

The maximum length of this information element is 3 octets. See Figure 4-7.

4.5.24 Progress indicator

See 4.5.23/Q.931.

4.5.25 Repeat indicator

See 4.5.24/Q.931.

4.5.26 Segmented message

See 4.5.26/Q.931.

4.5.27 Transit network selection

See 4.5.29/Q.931.

4.5.28 User-user

See 4.5.30/Q.931.

NOTE – Only service 1 implicit user-to-user signalling is supported.

4.5.29 X.213 priority

The purpose of the priority information element is to allow the optional negotiation of priority for the frame mode call in support of OSI Connection-mode Network Service (CONS).

The priority information element is carried transparently by frame mode networks. The maximum length of this information element is 8 octets. See Figure 4-8 and Table 4-8.

TABLE 4-5/Q.933 (1 of 3)

Link layer core parameters information element

Maximum frame mode information field (FMIF) (octets 3, 3a, 3b, 3c and 3d)

The frame mode information field size is the number of user data octets after the address field and before the FCS field in a frame mode frame. The count is done either before zero-bit insertion or following zero-bit extraction. If the frame mode information field is symmetrical, octet 3a and 3b indicate the size in both directions, and octet 3c and 3d are absent. The maximum size of the frame mode information field is a system parameter and is identified as N203.

Outgoing maximum FMIF size (octets 3a and 3b)

The outgoing maximum FMIF size is used to indicate the maximum number of end user data octets in a frame for the calling user to the called user direction. The size is in octets and is encoded in binary.

Incoming maximum FMIF size (octets 3c and 3d)

The incoming maximum FMIF size is used to indicate the maximum number of end user data octets in a frame for the called user to the calling user direction. The size is in octets and is encoded in binary.

NOTE 1 – The maximum frame mode information field size allowed for the D-channel is 262 octets. For B- and H-channels a larger FMIF size is allowed (e.g. up to 4096 octets). The default value of the frame mode information field size is defined in Recommendation Q.922. The users may negotiate a maximum FMIF size that is lower than the maximum FMIF size that the network can deliver. The network is not required to enforce the negotiated FMIF value.

Throughput (octets 4, 4a, 4b, 4c and 4d)

The purpose of the throughput field is to negotiate the throughput for the call. Throughput is the average number of "frame mode information" field bits transferred per second across a user-network interface in one direction, measured over an interval of duration "T".

This field, when present in the SETUP message, indicates requested throughput, which is the lesser of the throughput requested by the calling user and throughput available from the network(s), but is not less than the minimum acceptable throughput. When present in the CONNECT message, it indicates the agreed throughput, which is the throughput acceptable to the calling user, the called user and the network(s).

If the throughput is asymmetrical (i.e. the values in the incoming and outgoing directions are different), octets 4a and 4b indicate throughput in the outgoing direction (from the calling user) and octets 4c and 4d indicate throughput in the incoming direction (to the calling user). If the throughput is symmetrical, octets 4a and 4b indicate throughput in both directions, and octets 4c and 4d are absent.

Throughput is expressed as an order of magnitude (in powers of 10) and an integer multiplier. For example, a rate of 192 kbit/s is expressed as 192×10^3.

Magnitude (octets 4a and 4c)

This field indicates the magnitude of the throughput. This is expressed as a power of 10.

Bits	
7 6 5	
0 0 0	10^0
0 0 1	10^1
0 1 0	10^2
0 1 1	10^3
1 0 0	10^4
1 0 1	10^5
1 1 0	10^6

All other values are reserved.

NOTE 2 – To ensure that various implementations will encode particular rates in a consistent fashion, the coding of the magnitude and multiplier shall be such that the multiplier is as small as possible; i.e. the multiplier shall not be evenly divisible by 10. For example, a rate of 192 kbit/s shall be expressed as 192×10^3, not as 1920×10^2.

Multiplier (octets 4a, 4b, 4c and 4d)

This field indicates, in binary, the value by which the magnitude shall be multiplied to obtain the throughput.

TABLE 4-5/Q.933 (2 of 3)

Link layer core parameters information element

Minimum acceptable throughput

The purpose of the minimum acceptable throughput field is to negotiate the throughput for the call. Minimum acceptable throughput is the lowest throughput value that the calling user is willing to accept for the call. If the network or the called user is unable to support this throughput, the call shall be cleared.

This field which is present only in the SETUP message, is carried unchanged through the network(s). Its value may not be greater than the requested throughput.

If the minimum acceptable throughput is asymmetrical (i.e. the values in the incoming and outgoing directions are different) octets 5a and 5b indicate minimum acceptable throughput in the outgoing direction (from the calling user) and octets 5c and 5d indicate minimum acceptable throughput in the incoming direction (to the calling user). If the minimum acceptable throughput is symmetrical, octets 5a and 5b indicate throughput in both directions, and octets 5c and 5d are absent.

Minimum acceptable throughput is expressed as an order of magnitude (in powers of 10) and an integer multiplier. For example, a rate of 192 kbit/s is expressed as 192×10^3.

Magnitude (octets 5a and 5c)

Same as octets 4a and 4c coding.

Multiplier (octets 5a, 5b, 5c and 5d)

This field indicates, in binary, the value by which the magnitude shall be multiplied to obtain the minimum acceptable throughput.

Committed burst size

This field indicates the maximum amount of data (in bits) that the network agrees to transfer, under normal conditions, over a measurement interval (T). This data may or not may be interrupted (i.e. may appear in one frame or in several frames, possibly with inter-frame idle flags). T is calculated using the following combinations shown below:

Throughput	Committed burst size (Bc) (Note 3)	Excess burst size (Be)	Measurement interval (T)
> 0	> 0	> 0	T = Bc/Throughput
> 0	> 0	= 0	T = Bc/Throughput
= 0	= 0	> 0	Default (Note 4) T = Be/Access rate

NOTE 3 – The coding of this field is in octets. Therefore, the committed burst size is 8 × the contents of this field. If the committed burst size is symmetrical, octets 6a and 6b indicate the size in both directions, and octets 6c and 6d are absent.

NOTE 4 – However, the ingress and egress Access Rate (AR) do not have to be equal. However, when the ingress AR is substantially higher than the egress AR, continuous input of Be frames at the ingress interface may lead to persistent congestion of the network buffers at the egress interface, and a substantial amount of the input Be data may be discarded. Networks may define the interval T to be less than Be/AR in which case the default is not used.

Outgoing committed burst size (octets 6a, 6b)

The outgoing committed burst size (in octets) is binary coded.

Incoming committed burst size (octets 6c, 6d)

The incoming committed burst size (in octets) is binary coded.

Excess burst size

This field indicates the maximum amount of uncommitted data (in bits) that the network will attempt to deliver over measurement interval (T). This data may appear in one frame or in several frames. If the data appears in several frames, these frames can be separated by inter-frame idle flags. Excess burst may be marked Discard Eligible (DE) by the network.

NOTE 5 – The coding of this field is in octets. Therefore, the excess burst size is 8 × the contents of the field.

If the excess burst size is symmetrical, octets 7a and 7b indicate the size in both directions, and octets 7c and 7d are absent.

Outgoing excess burst size (octets 7a, 7b)

The outgoing excess burst size (in octets) is binary coded.

Incoming excess burst size (octets 7c, 7d)

The incoming excess burst size (in octets) is binary coded.

TABLE 4-5/Q.933 (3 of 3)

Link layer core parameters information element

Committed burst size magnitude (octets 8 and 8a)

The purpose of the Committed burst size magnitude is to magnitude of the Committed burst size. It is expressed as a power of 10. It is multiplied by the Committed burst size value (octet group 6) to give the actual value of the Committed burst size. When the incoming Committed burst size field is not included (in octet group 6), the incoming magnitude has no significance.

The outgoing and incoming Bc magnitudes are coded as follows:

Bits 3/6	2/5	1/4	
0	0	0	10^0
0	0	1	10^1
0	1	0	10^2
0	1	1	10^3
1	0	0	10^4
1	0	1	10^5
1	1	0	10^6

All other valfues are reserved.

Excess burst size magnitude (octets 9 and 9a)

The purpose of the Excess burst size magnitude is to indicate magnitude of the Excess burst size. It is expressed as a power of 10. It is multiplied by the Excess burst size value (octet group 7) to give the actual field of the Excess burst size. When the incoming Excess burst size value is not included (in octet group 7), the incoming magnitude has no significance.

The outgoing and incoming Be magnitude are coded as a power of 10 as follows:

Bits 3/6	2/5	1/4	
0	0	0	10^0
0	0	1	10^1
0	1	0	10^2
0	1	1	10^3
1	0	0	10^4
1	0	1	10^5
1	1	0	10^6

All others values are reserved.

8	7	6	5	4	3	2	1	Octet
	Link layer protocol parameters							
0	1	0	0	1	0	0	1	1
	Information element identifier							
Length of link layer protocol parameters contents								2*
	Transmit window size identifier							
0 ext.	0	0	0	0	1	1	1	3*
1 ext.	Transmit window value							3a*
	Retransmission timer identifier							4*
0 ext.	0	0	0	1	0	0	1	(Note 2)
0 ext.	Retransmission timer value							4a*
1 ext.	Retransmission timer value (cont.)							4b*
	Mode of operation							5*
0 ext.	0	0	0	1	1	1	1	(Note 3)
1 ext.	Spare					Mode Indication		5a*

NOTES

1 All parameters are optional and position independent. For the Frame Switching bearer service, if any parameters are omitted from the information element, the default values defined in Recommendation Q.922 apply. For Frame Relaying bearer service, if any parameters are omitted from the information element, the default values specified for the end-to-end link layer protocol apply.

2 In case of frame relay bearer service, Layer 2 elements of procedures are end-to-end. The acknowledgement timer value should be based on per-call cumulative transit delay. If included by the originating user, it will be based on the maximum end-to-end transit delay. The terminating user can adjust the value based on the cumulative transit delay.

3 Mode of operation is only included when the LLC octet 6 "user information layer 2 protocol" is coded with one of the codepoints: Recommendation X.25 link layer, Recommendation X.25 multilink, extended LAPB for half duplex operation (see Recommendation T.71) and Recommendation X.75 Single Link Procedure (SLP).

FIGURE 4-5/Q.933

Link layer protocol parameters information element

TABLE 4-6/Q.933

Link layer protocol parameters information element

Transmit window value (octet 3a)

The value of the maximum number of outstanding transmit I frames (window) is encoded as a binary encoded value between 1 and 127.

Retransmission timer value (octets 4a, 4b)

The retransmission timer (e.g. T200) value is binary encoded in multiples of tenths of a second.

Mode indication (octet 5a)

Bit
2 1
0 1 Basic mode – Modulo 8
1 0 Extended mode – Modulo 128
All other values are reserved.

NOTE – The default mode is basic mode – Modulo 8.

8	7	6	5	4	3	2	1	Octet
0	Low layer compatibility 1 1 1 1 1 0 0 Information element identifier							1
Length of the low layer compatibility contents								2
0/1 ext.	Coding standard		Information transfer capability					3
1 ext.	Negot. indic.	0	0	0	0 Spare	0	0	3a*
1 ext.	Transfer mode		0	0	0 Reserved	0	0	4 (Note 1)
0/1 ext.	0 1 Layer 1 ident.		User information layer 1 protocol					5*
0/1 ext.	Synch./ Asynch.	0 Spare	User rate					5a* (Note 2)
0/1 ext.	Hdr/ no Hdr/	Multiframe	Mode	0	0 Reserved	0	0 Spare	5b* (Note 2)
0/1 ext.	Number of stop bits		Number of data bits		Parity			5c* (Note 2)
1 ext.	Duplex mode	Modem type						5d* (Note 2)
0/1 ext.	1 2 Layer 2 ident.		User information layer 2 protocol					6* (Note 3)
1 ext.	0	0	0	0	0	Address inclusion		6a* (Note 3)
1 ext.	User specified							6a* (Note 4)
0/1 ext.	1 1 Layer 3 ident.		User information layer 3 protocol					7*
1 ext.	Optional layer 3 protocol information							7a*

NOTES

1 The configuration is assumed to be point-to-point; and the method of establishment is on demand.

2 This octet is present only if octet 5 indicates CCITT standardized rate adaption V.120.

3 This octet is included when a layer 2 address is included in the frame relay information field.

4 This octet may be present only if octet 6 indicates a user specified layer 2 protocol.

FIGURE 4-6/Q.933

Low layer compatibility information element

TABLE 4-7/Q.933

Low layer compatibility information element

Coding standard (octet 3)

Bits

7 6

0 0 CCITT standardized coding as described below

Information transfer capability (octet 3)

Bits

5 4 3 2 1

0 1 0 0 0 Unrestricted digital information

All other values are reserved.

Negotiation indicator (octet 3a)

Bits

7

0 Out-band negotiation not possible

1 Out-band negotiation possible

NOTE 1 – See Annex J/Q.931 for description of low layer compatibility negotiation.

NOTE 2 – When octet 3a is omitted, "out-band negotiation not possible" shall be assumed.

Transfer mode (octet 4)

Bits

7 6

0 1 Frame mode

All other values are reserved.

User information layer 1 protocol (octet 5)

Bits

5 4 3 2 1

0 1 0 0 0 CCITT standardized rate adaption V.120. This implies the presence of octets 5a and 5b described below, and optionally octets 5c and 5d.

All other values are reserved.

NOTE 3 – Octet 5 may be omitted. If octet 5 is omitted it is assumed that X.31 HDLC flag stuffing is used.

Synchronous/asynchronous (octet 5a)

Bit

7

0 Synchronous

1 Asynchronous

NOTE 4 – The protocol synchronous/asynchronous refers to R interface. In case of synchronous user rates except for half duplex operation, octet 5c-5d may be omitted for Recommendation V.120.

TABLE 4-7/Q.933 *(continued)*

Low layer compatibility information element

User rate (octet 5a)

Bits

5 4 3 2 1

0 0 0 0 0	Rate is indicated by E-bits specified in Recommendation I.460
0 0 0 0 1	0.6 kbit/s Recommendations V.6 and X.1
0 0 0 1 0	1.2 kbit/s Recommendation V.6
0 0 0 1 1	2.4 kbit/s Recommendations V.6 and X.1
0 0 1 0 0	3.6 kbit/s Recommendation V.6
0 0 1 0 1	4.8 kbit/s Recommendations V.6 and X.1
0 0 1 1 0	7.2 kbit/s Recommendation V.6
0 0 1 1 1	8 kbit/s Recommendation I.460
0 1 0 0 0	9.6 kbit/s Recommendations V.6 and X.1
0 1 0 0 1	14.4 kbit/s Recommendation V.6
0 1 0 1 0	16 kbit/s Recommendation I.460
0 1 0 1 1	19.2 kbit/s Recommendation V.6
0 1 1 0 0	32 kbit/s Recommendation I.460
0 1 1 1 0	48 kbit/s Recommendations V.6 and X.1
0 1 1 1 1	56 kbit/s Recommendation V.6
1 0 0 0 0	64 kbit/s Recommendation X.1
1 0 1 0 1	0.1345 kbit/s Recommendation X.1
1 0 1 1 0	0.100 kbit/s Recommendation X.1
1 0 1 1 1	0.75/1.2 kbit/s Recommendations V.6 and X.1 (Note 5)
1 1 0 0 0	1.2/0.075 kbit/s Recommendations V.6 and X.1 (Note 5)
1 1 0 0 1	0.050 kbit/s Recommendations V.6 and X.1
1 1 0 1 0	0.075 kbit/s Recommendations V.6 and X.1
1 1 0 1 1	0.110 kbit/s Recommendations V.6 and X.1
1 1 1 0 0	0.150 kbit/s Recommendations V.6 and X.1
1 1 1 0 1	0.200 kbit/s Recommendations V.6 and X.1
1 1 1 1 0	0.300 kbit/s Recommendations V.6 and X.1
1 1 1 1 1	12 kbit/s Recomendation V.6

All other values are reserved.

NOTE 5 – The first rate is the transmit rate in the forward direction of the call. The second rate is the transmit rate in the backward direction of the call.

Octet 5b for V.120 rate adaption

Rate adaptation header/no header (octet 5b)

Bits

7

0	Rate adaption header not included
1	Rate adaption header included

Multiple frame establishment support in data link (octet 5b)

Bits

6

0	Multiple frame establishment not supported. Only UI frames are allowed
1	Multiple frame establishment supported

TABLE 4-7/Q.933 *(continued)*

Low layer compatibility information element

Mode of operation (octet 5b)

Bits

5

0 Bit transparent mode of operation

1 Protocol sensitive mode of operation

Number of stop bits (octet 5c)

Bits

7 6

0 0 Not used

0 1 1 bit

1 0 1.5 bits

1 1 2 bits

NOTE 6 – If bit 7 of octet 5a is "0", then these bits, when present, are set to "0 0" on transmission and ignored on reception.

Number of data bits excluding parity (octet 5c)

Bits

5 4

0 0 Not used

0 1 5 bits

1 0 7 bits

1 1 8 bits

NOTE 7 – If bit 7 of octet 5a is "0", then these bits, when present, are set to "0 0" on transmission and ignored on reception.

Parity information (octet 5c)

Bits

3 2 1

0 0 0 Odd

0 1 0 Even

0 1 1 None

1 0 0 Forced to 0

1 0 1 Forced to 1

All other values are reserved.

NOTE 8 – If bit 7 of octet 5a is "0", then these bits, when present, are set to "0 1 1" on transmission and ignored on reception.

Duplex mode (octet 5d)

Bit

7

0 Half duplex

1 Full duplex

Modem type (octet 5d)

Bits 6-1 coded according to network specific rules.

TABLE 4-7/Q.933 *(continued)*

Low layer compatibility information element

User information layer 2 protocol (octet 6)

Bits

5 4 3 2 1

0 0 0 0 1 Basic mode ISO 1745

0 0 1 1 0 Recommendation X.25 link level (Note 9)

0 0 1 1 1 Recommendation X.25 multilink (Note 10)

0 1 0 0 0 Extended LAPB for half duplex operation (Recommendation T.71) (Note 9)

0 1 0 0 1 HDLC ARM (ISO/IEC 4335) (Note 11)

0 1 0 1 0 HDLC NRM (ISO/IEC 4335) (Note 11)

0 1 0 1 1 HDLC ABM (ISO/IEC 4335) (Note 11)

0 1 1 0 0 LAN logical link control (ISO/IEC 8802/2) (Notes 12 and 15)

0 1 1 0 1 Recommendation X.75, Single link procedure (SLP) (Note 9)

0 1 1 1 0 Recommendation Q.922 (Note 13)

0 1 1 1 1 Core aspects of Annex A/Q.922 (Note 16)

1 0 0 0 0 User specified (Note 14)

1 0 0 0 1 ISO/IEC 7776 DTE to DTE operation (Note 9)

All other values are reserved.

NOTE 9 – Normally the LAPB address is not provided. When provided, octet 6a will indicate that the address is present or octets 5, 5a, and 5b will indicate the use of synchronous protocol sensitive mode of V.120 terminal adaption. When the LAPB address is provided, the originating user assumes Address A (value 3) and the terminating user assumes Address B (value 1).

NOTE 10 – Normally the X.25 multilink address is not provided. When provided, octet 6a will indicate that the address is present or octets 5, 5a, and 5b will indicate the use of synchronous protocol sensitive mode of V.120 terminal adaption. When the X.25 multilink address is provided, the originating user assumes Address C (value 15) and the terminating user assumes Address D (value 7).

NOTE 11 – Normally the HDLC address is not provided. When provided, octet 6a will indicate that the address is present or octets 5, 5a, and 5b will indicate the user of synchronous protocol sensitive mode of V.120 terminal adaption.

NOTE 12 – Destination Service Access Point (DSAP) and Source Service Access Point (SSAP) are included. When a logical link control frame (which contains a logical link control PDU) is required (transparent inter-connections of similar LANs by frame relay), octet 6a will indicate that the logical link control frame is encapsulated. The contents of a logical link control frame is defined in the LAN Medium Access Control (MAC) standards (e.g. ISO/IEC 8802-5).

NOTE 13 – Address is not encapsulated.

NOTE 14 – When this coding is included, octet 6a will include the codepoint for user specified layer 2 protocol.

NOTE 15 – The indication of command or response bit in the frame relay address will be ignored.

NOTE 16 – This codepoint is only used in case A for circuit-switched connection establishment (see 5.1.1.1).

Octet 6a coding for user specified codepoint

User information layer 2 protocol (octet 6a) (applies for layer 2 = User specified)

User specified.

TABLE 4-7/Q.933 *(concluded)*

Low layer compatibility information element

Octet 6a coding for Address inclusion

User information layer 2 protocol (octet 6a) (Note 17)

Bits	
2 1	
0 1	Address included (Note 18)
1 0	Encapsulation of logical control frame (Note 19)

All other values are reserved.

NOTE 17 – When the octet is present, the indication of C/R bit in the frame relay core aspects address will be ignored.

NOTE 18 – Applies for the layer 2 protocols specified in octet 6 are: X.25 link layer, X.25 multilink, extended LAPB for half duplex operation (see Recommendation T.71), HDLC ARM, HDLC NRM, HDLC ABM, and X.75 single link procedure.

NOTE 19 – Applies for layer 2 protocol specified in octet 6 is LAN logical link control (ISO/IEC 8802-2).

User information layer 3 protocol (octet 7)

Bits	
5 4 3 2 1	
0 0 1 1 0	X.25 packet layer
0 0 1 1 1	ISO/IEC 8208 (X.25 packet level protocol for data terminal equipment)
0 1 0 0 0	Recommendation X.223 or ISO/IEC 8878 (use of ISO/IEC 8208 and Recommendation X.25 to provide the OSI-CONS)
0 1 0 0 1	ISO/IEC 8473 (OSI connectionless mode protocol)
0 1 0 1 0	T.70 minimum network layer
0 1 0 1 1	ISO/IEC TR 9577 (Protocol identification in the network layer)
1 0 0 0 0	User specified (Note 20)

All other values are reserved.

NOTE 20 – When this coding is included, octet 6a will include the codepoint for user specified layer 3 protocol.

Optional layer 3 protocol information (octet 7a)

User specified.

8	7	6	5	4	3	2	1	Octet
0	Packet layer binary parameters 1 0 0 0 1 0 0 Information element identifier							1
Length of packet layer binary parameters contents								2
1 ext.	0 0 Spare		0 0 Reserved		Exp. data	Receipt conf.	0 Reserve	3

Expedited data (octet 3)

Bit
3
0 No request/request denied
1 Request indicated/request accepted

Recipt confirmation (octet 3) (Note)

Bit
2
0 No request/request denied
1 Request indicated/request accepted

NOTE – The receipt confirmation is end-to-end.

FIGURE 4-7/Q.933

Packet layer binary parameters information element

8	7	6	5	4	3	2	1	Octet
0	X.213 priority 1 0 1 0 0 0 0 Information element identifier							1
Length of the X.213 priority contents								2
0/1 ext.	0	0 Spare	0	Priority of data on a connection				3
1 ext.	0	0 Spare	0	Lowest acceptable priority of data on a connection				3a*
0/1 ext.	0	0 Spare	0	Priority to gain a connection				4* (Notes 1, 3)
1 ext.	0	0 Spare	0	Lowest acceptable priority to gain a connection				4a*
0/1 ext.	0	0 Spare	0	Priority to keep a connection				5* (Notes 2, 3)
1 ext.	0	0 Spare	0	Lowest acceptable priority to keep a connection				5a*

NOTES

1 Octets 4 and 4a are optional. If present, octet 3 must also be present.

2 Octets 5 and 5a are optional. If present, octets 3 and 4 must also be present.

3 Specification of a value in a particular octet requires that all preceding 0/1ext. octets be present although they may be considered optional; in such a case, the preceding octets would carry the value “unspecified”. A missing octet is equivalent to the value “unspecified”.

FIGURE 4-8/Q.933

X.213 priority information element

TABLE 4-8/Q.933

X.213 priority information element

All priority parameters take a value in the range of 0 (lowest priority) to 14 (highest priority). The value 15 is to be used to indicate an "unspecified" priority value. If the subparameter(s) for all priority parameters are unspecified, then the information element is not transmitted. If the lowest acceptable is not specified, then (a) octet is omitted. All parameters are encoded as binary encoded values between 0 and 15.

5 Frame mode call control procedures

This clause describes the signalling procedures in the support of frame mode communications in an Integrated Services Digital Network.

The user may access frame handing facilities by means of one of the following alternatives:

1) circuit-switched access to a remote frame handler (case A) by establishing bearer channel (B or H) associated frame mode connections. This connection may be initiated by the user or the RFH. In this case, the frame mode network handler is provided using in-channel signalling. By prior agreement, (e.g. by subscription) the frame mode network handler may instead be provided not using in-channel signalling; or

2) access to the frame mode virtual circuit service on the local ISDN (case B) by establishing a frame mode connection. This connection may be initiated by the user or the frame handler. Either bearer channel or D-channel may be used for frame mode data transport.

The term "user" refers to the user equipment which may consist of an ISDN frame mode terminal (TE1) or a combination of an existing data terminating equipment (TE2) attached to a terminal adapter (TA). A TE2 may not receive all of the information provided in Q.931 signalling messages at the user-network interface.

The ISDN TA/TE1 presents an S/T reference point interface towards the network and therefore the TA/TE1 implementation should embody the procedures described in Recommendation Q.931 and this Recommendation for B- and D-channel connection establishment control.

Two physical types of semi-permanent connections are possible via the B- and D-channels:

1) physical layer connection semi-permanently established between the user and the frame handler (FH)/RFH, i.e. the physical layer remains activated and the physical path is connected semi-permanently;

2) data link and physical layers semi-permanently established between the users (in this type, the network shall maintain the data link layer connection identifier information).

In semi-permanent connections as indicated in 1) above, the procedures in 5.1.1.2 and 5.1.2 and in 5.2.1.2 and 5.2.2 are followed for call establishment. The procedures in 5.4 are followed for call release. It should be noted that, in the case of the Frame Relaying bearer service, the link layer establishment and release procedures are end-to-end, and are dependent on the link layer protocol being operated between the users.

In semi-permanent connections as indicated in 2) above, administrative procedures not specified in this Recommendation are followed for call establishment and release.

The procedures described in this Recommendation allow the delivery of the calling party number information element and the connected number information element. Some networks providing this capability may choose to implement the procedures described in supplementary services Calling Line Identification Presentation (CLIP) and Connected Line Identification Presentation (COLP) (see Recommendation Q.951).

5.1 Outgoing call

For outgoing data calls, the user must first decide whether case A services or case B services are desired from the network. For outgoing case A calls, the user follows the procedures in 5.1.1. For outgoing case B calls, the user decides whether:

- the network shall select the channel (see 5.1.3.1); or
- a specific B-channel is to be used; or
- the D-channel is to be used;

for the frame mode call.

5.1.1 Circuit-switched access to remote frame handling services (Case A)

A circuit-switched connection between the originating user and the RFH must be in place before the frame mode connections can be established. If the connection has not been previously established, the procedures, messages, and information elements of Recommendation Q.931 shall be used to establish the connection (see below).

5.1.1.1 Circuit-switched connection establishment

If such a connection is not already established, the originating user shall initiate the establishment of the circuit-switched connection prior to attempting origination of the frame mode connection. It does so by sending a SETUP message on the D-channel in which the Called party number information element is coded with the address of the RFH, and the Bearer capability information element is coded with:

- information transfer capability set to “unrestricted digital information”;
- transfer mode set to “circuit mode”; and
- information transfer rate set to the bit rate of the bearer channel.

The Low layer compatibility information element is optionally included.

Once establishment of the circuit-switched connection is complete, if in-channel signalling is to be used, the originating user proceeds with any desired initialization procedure (e.g. XID exchange, SABME/UA) on the logical link identified by data link connection identifier DLCI = 0 within the bearer channel between itself and the RFH; the link layer protocol employed on the DLCI = O logical link is that defined in Recommendation Q.922. The originating user then proceeds with the establishment of the frame mode connection. See Table 5-1.

TABLE 5-1/Q.933

Establishment of connection for frame mode services

<table>
<tr><td rowspan="3">Establishment of access connection</td><td>Demand</td><td>Semi-permanent access connection</td><td>Semi-permanent frame mode connection</td></tr>
<tr><td>Case A: Demand, using Q.931 procedures for Circuit mode bearer service</td><td rowspan="2">Semi-permanent (Note 1)</td><td rowspan="2">Semi-permanent (Note 1)</td></tr>
<tr><td>Case B: Demand, using Q.933 procedures</td></tr>
<tr><td rowspan="2">Establishment of frame mode connection</td><td>Case A: Demand, using Q.933 procedures on DLCI 0 in the bearer channel</td><td>Case A: Demand, using Q.933 procedures on DLCI 0 in the bearer channel</td><td rowspan="2">Semi-permanent (Note 1)

(Note 2)</td></tr>
<tr><td>Case B: Demand, using Q.933 procedures on the D-channel</td><td>Case B: Demand, using Q.933 procedures on the D-channel</td></tr>
<tr><td colspan="4">NOTES
1 For example, using administrative procedures.
2 In case of semi-permanent frame mode connections, parameter values are defined at subscription time.</td></tr>
</table>

5.1.1.2 Frame mode connection setup

The procedures employed are identical to those defined in Recommendation Q.931 except for the following:

1) the connection control message flow is on the logical link identified by DLCI = 0 within the bearer channel, rather than on the D-channel;

2) the structure of the connection control messages exchanged shall be as shown in clause 3, and the information elements carried by these messages shall be coded in accordance with clause 4;

3) the channel identification information element shall be used as specified in 5.1.3.1;

4) the use of Data link connection identifier information element for data link connection identifier negotiation shall be as specified in 5.1.3.2; and

5) parameter negotiation shall be as specified in 5.1.3.3;

6) the SETUP message is offered on a point-to-point data link and shall be delivered to layer 2 using a DL-DATA-request primitive. Point-to-multipoint procedures are not used;

7) a user indicates acceptance of an incoming call by sending a CONNECT message to the network and entering the Active state. Sending CONNECT ACKNOWLEDGE message to the user by the network after receipt of CONNECT message is optional. The user shall not take any action on receipt of a CONNECT ACKNOWLEDGE message when it perceives the call to be in the Active state.

In the SETUP message sent to the frame handler by the originating user, the Bearer capability information element shall be coded as specified in 5.1.2.

The Low layer compatibility information element is included when the calling user wants to pass compatibility information to the called user. The layer 2 protocol to be coded in the Low layer compatibility information element is that which will operate end-to-end between the communicating TEs during the data transfer phase. When Low layer compatibility negotiations are required, procedures described in Annex J/Q.931 will be followed.

The SETUP message may include either or both the Channel identification information element and the Data link connection identifier information element. Alternatively, it may contain neither one. See 5.1.3 below.

Note that the call reference value associated with the frame mode connection is unrelated to that associated with the underlying circuit-switched connection.

Additional frame mode calls can be established on an already established bearer channel by using the procedures described above.

5.1.2 Access to the ISDN frame mode virtual circuit service (case B)

Frame mode calls are controlled using D-channel signalling procedures (in SAPI 0) as described in clause 5/Q.931 except for the following:

1) the structure of the connection control messages exchanged shall be as shown in clause 3, and the information elements carried by these messages shall be coded in accordance with clause 4;

2) the channel identification information element shall be used as specified in 5.1.3.1;

3) the use of Data link connection identifier information element for data link connection identifier negotiation shall be as specified in 5.1.3.2; and

4) parameter negotiation shall be as specified in 5.1.3.3.

For a demand connection to an ISDN frame handler, the Bearer capability information element included in the SETUP message shall be encoded with:

– information transfer capability set to "unrestricted digital information";

– transfer mode set to “rame mode”; and

– user information layer 2 protocol set to:

  a) “Core aspects of frame mode” in case of Frame Relaying bearer service; or

  b) “Recommendation Q.922”, in case of Frame Switching bearer service.

The Low layer compatibility information element is included when the calling user wants to pass compatibility information to the called user. The layer 2 protocol to be coded in the Low layer compatibility information element is:

1) the protocol which will operate end-to-end between the communicating TEs during the data transfer phase in case of Frame Relaying service;

2) "Recommendation Q.922", in case of Frame Switching service.

When low layer compatibility negotiations are required, procedures described in Annex J/Q.931 will be followed.

5.1.3 Negotiation

5.1.3.1 Channel negotiation

In case A, no channel negotiation between the user and the RFH is possible, as the ISDN establishes the circuit-switched connection prior to the user establishing the communication with the RFH. As a result, the Channel identification information element is optional. When present, it shall be coded as:

– Channel indication – "No Channel";

– Preferred/Exclusive – "Exclusive"; and

– D-channel indications – "No".

If other codings are used, the Channel identification information element is ignored and the above encoding is assumed. The procedures of 5.8.7.2/Q.931 will apply.

The first response to the SETUP message (e.g. – CALL PROCEEDING) will contain the Channel identification information element coded as above, regardless of whether the Channel identification information element was present in the SETUP message.

In case B, the channel negotiation procedures described in 5.1.2/Q.931 apply. However, since the frame mode connection may also be added to the D-channel or to existing channels under the control of the user and being used for frame mode the valid encodings are expanded and shown in Table 5-2.

As specified in Recommendation Q.931 when the channel identification information is absent, it is interpreted as "Any channel", "Preferred", D-channel indication "Yes".

The first response to the SETUP message (e.g. – CALL PROCEEDING) will contain the Channel identification information element encoded to indicate the specific channel to be used.

5.1.3.2 Data link connection identifier negotiation

In case A, the Data link connection identifier information element may appear without regard for the appearance or absence of the Channel identification information element, as the channel is always implicitly understood, as being the bearer channel negotiated during step 1 (circuit mode call establishment) of frame mode call establishment procedure.

In the Data link connection identifier information element in the SETUP message, the user will indicate one of the following:

1) an exclusive DLCI with no acceptable alternative; or

2) a preferred DLCI (in this case it is understood that the user is willing to accept any other DLCI).

In case B, the user may include the Data link connection identifier information element in the SETUP message to request the use of a particular DLCI for the requested frame mode call. This information element may be encoded to indicate that the specific DLCI is:

1) an exclusive DLCI with no acceptable alternative.

   This option is only allowed if the channel identification information element was included in the SETUP message and encoded for one of:

   a) an exclusive B- or H-channel with a D-channel indication = "No"; or

   b) no channel exclusive with a D-channel indication = "Yes".

If the Data link connection identifier information element is encoded for an exclusive DLCI and the above condition is not met, then the Data link connection identifier information element should be treated as an invalidly encoded optional information element and ignored.

2) A preferred DLCI (In this case it is understood that the user is willing to accept any other DLCI.)

NOTE – Only DLCIs indicated as "assigned using frame mode connection procedures" in Recommendation Q.922 shall be assigned.

In both cases, if the indicated DLCI is available on the requested channel, the network reserves that DLCI for the call.

If the network cannot grant the indicated DLCI on the requested channel (in case 2), or if the user does not include a DLCI information element in the SETUP message, the network reserves an available DLCI within the channel to be used.

TABLE 5-2/Q.933

Channel identification information element encodings outgoing calls – Case B

Channel indicated in the SETUP message user to network direction			Allowable network response
Channel indication	Preferred or Exclusive	D-channel indicator	Network → user
Ci	Preferred	No	Cj (Note 1)
		Yes	Cj, D (Note 2)
	Exclusive	No	Ci
		Yes	Ci, D
Any channel	Preferred	No	Cj
		Yes	Cj, D
No channel	Preferred	No	Ck
		Yes	Ck, D
	Exclusive	Yes	D
Channel identification information element not included			Cj, D

Ci The indicated B- or H-channel that must be either an idle channel or an established channel under the control of the user being used for frame mode

Cj Any B- or H-channel that either is idle or, if established, is under the control of the user and is being used for frame mode

Ck An established B- or H-channel that is under the control of the user and is being used for frame mode

D The D-channel

NOTES

1 When possible, the network should choose the user preferred channel.

2 If a B- or H-channel is to be used, the network should, if possible, choose the user preferred channel.

3 All other encoding are invalid.

4 The actual coding for D-channel indicator will be: No → 0; Yes → 1.

If a requested DLCI, which is identified as exclusive, is not available, a RELEASE COMPLETE message is sent with cause #44, "requested circuit/channel not available". If no DLCI is available on any channel, when both the requested channel and requested DLCI are identified as preferred in the SETUP message, or if the requested DLCI was indicated as preferred and the channel was identified as exclusive and there is no DLCI available, a RELEASE COMPLETE message is sent with cause #34, "no circuit/channel available".

5.1.3.3 Parameter negotiation

5.1.3.3.1 Rationale

The QOS parameters (throughput and cumulative transit delay) are negotiated during frame mode call establishment. These parameters include requested and lowest acceptable quality values. Other link layer core parameters that are negotiated are:

1) frame relaying bearer service: frame mode information field size, committed burst size, and excess burst size;

2) frame switching bearer service: frame mode information field size.

These parameters are negotiated between calling user, the network, and the called user.

In addition, in case of Frame Switching bearer service, the link layer protocol parameters (e.g. transmit window size, retransmission timer T200) may be negotiated. The link layer protocol parameters are not considered to be part of the QOS parameters.

Based on the network resources available to provide the requested QOS, the network will decide whether to:

1) reject the call if lowest quality acceptable service requirements cannot be satisfied by the available network resources;

2) continue establishing the call with the requested Quality of Service if they can be supported by the network; or

3) continue establishing the call with adjusted values of Quality of Service parameters which can be supported by the network.

5.1.3.3.2 Parameter negotiation procedures

When a user establishes a frame mode connection, it may require a certain Quality of Service from the network. The user may request certain parameters to be used for the connection by including the appropriate information elements containing the desired parameters in the SETUP message.

If the user does not specify a value for a particular parameter, then a default value is assumed. Default values may be network specific or may be established by subscription. This applies to both QOS and link layer core parameters.

Upon receipt of a SETUP message, after examining the QOS parameters and link layer specified parameter values, the network can take one of the following actions:

1) *Frame Relaying bearer service*

   – If able to provide the requested QOS, and able to support the indicated link layer core parameter values, the network will progress the call to the called user, with the original parameters.

   – If unable to provide the requested QOS, but able to provide at least the lowest acceptable QOS, the network will progress the call to the called user, after adjusting the requested QOS parameters. The adjusted QOS parameters will support at least the lowest quality acceptable values.

   When progressing the call, the network may, if necessary, also adjust the following link layer core parameters by reducing the requested values: maximum frame mode information field size; committed burst size; and excess burst size. The network may adjust either or both "incoming" and "outgoing" sub-parameters of these three parameters.

   – If unable to provide at least the lowest acceptable QOS, the network will reject the call, returning a RELEASE COMPLETE message with cause #49, "Quality of Service" not available.

2) *Frame Switching bearer service*

The same actions as described in 1) will be taken, but only relevant link layer core parameters (i.e. maximum frame mode information field size) will be considered.

In addition the link layer protocol parameters may be negotiated locally.

5.2 Incoming call

5.2.1 Access from a Remote Frame Handler (RFH) service (Case A)

A circuit-switched connection between the RFH and the called user must be in place before the incoming frame mode call can be offered.

5.2.1.1 Circuit-switched connection establishment

If such a connection is not already established, the RFH shall initiate the establishment of the circuit-switched connection prior to offering the frame mode connection. The procedures followed in offering this connection are the procedures for circuit-switched connections in Recommendation Q.931. In this case, the Bearer capability information element included in the SETUP message shall be coded as specified in 5.1.1.

Once establishment of the circuit-switched connection is complete, the RFH performs any desired initialization procedure (e.g. optionally XID exchange, SABME/UA) on the logical link using DLCI = 0 within the bearer channel between itself and the called user; the link layer protocol employed on the DLCI logical link is that defined in Recommendation Q.922. The RFH then offers the frame mode call to the called user as defined in the following subclause.

5.2.1.2 Frame mode connection establishment

The procedures employed are identical to that defined in Recommendation Q.931, except the following:

1) the connection control message flow is on the logical link identified by DLCI = 0 within the bearer channel, rather than on the D-channel;

2) the structure of the connection control messages exchanged shall be as shown in clause 3, and the information elements carried by these messages shall be coded in accordance with clause 4;

3) the Channel identification information element shall be used as specified in 5.2.3.1;

4) the use of Data link connection identifier information element for data link connection identifier negotiation shall be as specified in 5.2.3.2; and

5) parameter negotiation shall be as specified in 5.2.3.3.

In the SETUP message sent by the RFH to the called user, the Bearer capability information element shall be coded as specified in 5.1.2.

The call reference value associated with the frame mode connection is unrelated to that associated with the underlying circuit-switched connection.

Additional frame mode calls can be established on an already established bearer channel by using the procedures described above.

5.2.2 Access from the ISDN frame mode virtual circuit service (Case B)

When an incoming call is to be offered, the physical channel and logical link to be used must be identified. The identification mechanism may employ customer profile information, availability of network resources, and call offering procedures.

Call offering procedures shall be such that:

a) A new incoming frame mode call may be indicated to the user by a call offering procedure between the network and all terminals eligible to receive the call.

b) When a call is offered to an interface on which a frame mode connection is already established within the bearer channel, the user should have the option of accepting the new call in the same bearer channel, so long as there is sufficient bandwidth available within this channel.

The SETUP message sent by the network will have its Bearer capability information element coded as specified in 5.1.2.

Channel negotiation procedures are described in 5.2.3.1. Procedures for DLCI negotiation are described in 5.2.3.2.

5.2.3 Negotiation

5.2.3.1 Channel selection through call offering

5.2.3.1.1 Case A specific information

In case A, the only allowed encoding of the Channel identification information element is "No channel", "Exclusive", and D-channel indication "No". If the Channel identification information element is absent either from the SETUP message or the response, the above encoding is assumed.

If other codings are used, the information element is ignored and the above coding is assumed. A STATUS message may be returned with cause #100 "invalid information element contents".

5.2.3.1.2 Case B specific information

In case B, the network shall always include the Channel identification information element in the SETUP message.

The user shall include the Channel identification information element in a CALL PROCEEDING, an ALERTING, or a CONNECT message sent as the first response to a SETUP message. The valid encodings of the Channel identification information element are shown in Table 5-3.

The network shall respond to a CONNECT message from the selected user with a CONNECT ACKNOWLEDGE message. The network shall also return a RELEASE message containing cause #26 "non-selected user clearing" to any other positively responding terminals. The network will then deliver the frame mode call over the selected channel.

The channel selection procedure for incoming calls is independent of the type of channel selected at the calling end. In this respect, any combination of channel type used at each end is possible, provided the user rates and available bandwidth are compatible.

The channel negotiation principle to be used is shown in Table 5-3.

5.2.3.2 Data link connection identifier negotiation

In case A, the procedures are identical to those described in 5.1.3.2 with exceptions that the RFH always includes the Data link connection identifier information element in a SETUP message.

In case B, the Data link connection identifier information element shall be included in the SETUP message. The Data link identifier information element shall be encoded to indicate that the specified DLCI is either:

1) an exclusive DLCI with no acceptable alternative. This option is only allowed if the Channel identification information element was included in the SETUP message and encoded for one of:

   a) an exclusive B- or H-channel, D-channel indication equal to "No";

   b) no channel exclusive, D-channel indication equal to "Yes"; or

2) a preferred DLCI.

NOTE – Only DLCIs indicated as "assigned using frame mode connection procedures" in Recommendation Q.922 shall be assigned.

The user shall include the Data link connection identifier information element in a CALL PROCEEDING, an ALERTING, or a CONNECT message sent as the first response to a SETUP message. The value indicated for the DLCI shall be a value available on the channel indicated by the Channel identification information element included in this response. If either:

- the DLCI information element in the SETUP was coded "exclusive"; or
- the channel identification information element in the first response to the SETUP indicates the D-channel, and the SETUP message was delivered by a broadcast data link;

then the value of the DLCI indicated in this response shall be the same as a value of the DLCI received in the SETUP message.

TABLE 5-3/Q.933

Channel identification information element encodings incoming calls – Case B

Channel indicated in the SETUP message user to network direction			Allowable user response
Channel indication	Preferred or Exclusive	D-channel indicator	User → Network
Ci	Preferred	No	Ci, Cj (Note 1), Ck
		Yes	Ci, Cj, (Note 1), Ck, D
	Exclusive	No	Ci
		Yes	Ci, D
No Channel	Preferred	No	Ck
		Yes	Ck, D
	Exclusive	Yes	D

Ci The indicated idle B- or H-channel

Cj Any idle B- or H-channel different from the indicated one

Ck An established B- or H-channel that is under the control of the user and is being used for frame mode calls

D The D-channel

NOTES

1 This encoding is not permitted in response to broadcast call offering.

2 All other encodings are invalid.

3 The actual coding for D-channel indicator will be: No → 0; Yes → 1.

5.2.3.3 Parameter negotiation

Upon receipt of a SETUP message, the user examines the Quality of Service parameter values and other link layer core parameter values. The user can take one of the following actions:

1) if able to provide the indicated Quality of Service the user will accept the call and return a CONNECT message with the original "parameters";

2) if unable to provide the indicated Quality of Service but able to provide at least the lowest acceptable Quality of Service, the user will accept the call and return a CONNECT message after adjusting the request Quality of Service parameters. The adjusted Quality of Service parameters will be at least the lowest quality acceptable values;

3) if unable to provide at least the lowest acceptable Quality of Service, the user will reject the call, returning a RELEASE COMPLETE message with cause #49, "Quality of Service not available".

When accepting the call by returning a CONNECT message, the user may also adjust the link layer core parameter values by reducing the requested values.

In addition to the above the Link Layer Protocol Parameters (LLPP) are examined and the following actions are taken:

1) *Frame Relaying bearer service*

   – if link layer protocol parameters are acceptable, the indicated LLPP should be included in the CONNECT message;

   – if LLPP are not acceptable, the new proposed LLPP shall be included in the CONNECT message.

In either case, LLPP is carried transparently by the network.

2) *Frame Switching bearer service*

Link layer protocol parameters are negotiated locally.

The parameter values indicated in the CONNECT message are those used for the connection. The FH/RFH, upon receiving the CONNECT message, accepts the call by responding with a CONNECT ACKNOWLEDGE message and establishing the call on the selected channel. These parameter values shall also be carried transparently by the network and delivered to the calling user in a CONNECT message.

5.3 Frame mode data transfer phase protocol

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

Upon establishing the frame mode connection, the frame mode data transfer phase procedures shall be followed.

1) *Frame Relaying bearer service*

Core aspects of the frame mode protocol.

2) *Frame Switching bearer service*

See Recommendation Q.922.

In case of Frame Relaying bearer service, the link layer is established and released according to the procedures of the link layer protocol being operated between the users.

5.4 Call clearing

Call clearing procedures for Frame Mode bearer services are based on 5.3/Q.931.

5.4.1 Terminology

For frame mode calls, the definitions of 5.3.1/Q.931 are extended, and the following apply:

– a DLCI is “connected” when it is being used in a frame mode connection;

– a DLCI is “disconnected” when it is no longer being used in a frame mode connection (i.e. frames are no longer being transferred using that DLCI), but the DLCI is not yet available for use in a new frame mode connection;

– a DLCI is “released” when it is not being used in a frame mode connection and is available for use in a new frame mode connection.

5.4.2 Exception conditions

In addition to the exception conditions noted in 5.3.2/Q.931, unsuccessful termination of the DLCI negotiation procedure for frame mode call is accomplished by sending RELEASE message with cause #6 “channel unacceptable”. Items b) and d) of 5.3.2/Q.931 do not apply to frame mode calls for Case A (but do apply for the underlying circuit mode call).

5.4.3 Clearing initiated by the user

Subclause 5.3.2/Q.931 applies to frame mode calls, as follows:

1) The user shall disconnect the DLCI upon sending the DISCONNECT message. For Case B using the B-channel, the B-channel is also disconnected when there are no additional frame mode calls on that B-channel and the physical layer connection is not semi-permanently established.

2) Upon receipt of the DISCONNECT message, the network shall disconnect the DLCI. For Case B using B-channel, the B-channel is also disconnected when there are no additional frame mode calls on that B-channel and the Physical layer connection is not semi-permanently established.

3) On receipt of the RELEASE message, the user shall release the DLCI, in addition to the Call reference. It shall also release B-channel, if it was disconnected per 1) above.

4) On receipt of the RELEASE COMPLETE message, the network shall release the DLCI, in addition to the Call reference. It shall also release the B-channel if it was disconnected per 2) above.

For Case A connections, clearing of an underlying circuit-switched connection may be initiated by the user or the Frame Handler using Q.931 clearing procedures, when no active frame mode connections remain within it.

5.4.4 Clearing initiated by the network

Subclause 5.3.4.2/Q.931 and 5.3.4.3/Q.931 apply to frame mode calls, as follows:

1) The network shall disconnect the DLCI upon sending the DISCONNECT message. For Case B using the B-channel, the B-channel is also disconnected when there are no additional frame mode calls on that B-channel and the Physical layer connection is not semi-permanently established.

2) Upon receipt of the DISCONNECT message the user shall disconnect the DLCI. For Case B using B-channel, the B-channel is also disconnected when there are no additional frame mode calls on that B-channel and the Physical layer connection is not semi-permanently established.

3) On receipt of the RELEASE message, the network shall release the DLCI, in addition to the Call Reference. It shall also release B-channel if it was disconnected per 1) above.

4) On receipt of the RELEASE COMPLETE message the user shall release the DLCI, in addition to the Call reference. It shall also release the B-channel, if it was disconnected per 2) above.

For Case A connections, clearing of an underlying circuit-switched connection may be initiated by the user or the Frame Handler by using Q.931 clearing procedures, when no active frame mode connections remain within it.

5.5 Restart procedures

The restart procedures for the Frame Mode bearer services generally follow those of 5.5/Q.931.

5.5.1 Case A

The procedures of 5.5/Q.931 apply to the circuit-mode access connection. When the bearer channel is released by restart procedure, all frame mode connections on that bearer channel [with the associated call reference value(s) and DLCI value(s)] are released, in a manner identical to that discussed in 5.7, below. Recommendation Q.931 restart procedures do not apply to semi-permanently established bearer channels; therefore, in either case of semi-permanent connection (see Figure 1-1), the restart procedures do not affect frame mode calls.

NOTE – No restart procedures are used within the bearer channel (DLCI = O).

5.5.2 Case B

The procedures of 5.5/Q.931 are enhanced to take into account frame mode calls.

When a RESTART message is received by the DSS 1 protocol control entity with the Global call reference, indicating one or more channels or interface(s), supporting frame mode calls, it shall initiate internal clearing procedures for all appropriate frame mode calls active on the indicated channel(s) or interface(s).

Specifically, the Layer 2 entity associated with each call (core aspects, in case of Frame Relaying) shall:

a) stop sending frames;

b) indicate to higher layers that the frame mode connection has been disconnected;

c) release the DLCI value.

For each cleared frame mode call, the DSS 1 frame mode protocol control entity shall then:

1) return the frame mode call to the Null state;

2) release the call reference;

3) if there are no other frame mode calls using the indicated B-channel and the B-channel is not semi-permanent, return the B-channel to the Released state (see 5.3.1/Q.931).

When all calls associated with the specified channel(s) or interface(s) have been cleared, either by these procedures or by those of 5.5.2/Q.931, a RESTART ACKNOWLEDGE message shall be sent.

5.6 Call collision

The procedures of Recommendation Q.931 are used.

Whenever an attempt is made to use the same DLCI value for different calls at a given interface, priority will be given to the incoming call.

5.7 Handling of error conditions

In general, the procedures of Recommendation Q.931 are used. When a Case A connection is released prior to the release of the frame mode connections within it, the users have the responsibility of releasing the frame mode connections on that circuit-switched channel. However, if the users fail to release the frame mode connections, it is the responsibility of the RFH to release the frame mode connection towards the remote users.

Case A of Recommendation Q.933 does not support the Global call reference. There are several error conditions related to the Global call reference, which shall be handled as follows:

The following cases are addressed:

1) On receipt of a STATUS message with the Global call reference, no action shall be taken on the STATUS message.

2) On receipt of a message with the Global call reference, a STATUS message with cause # 81 “invalid call reference value” is returned. The call reference is coded with the Global call reference and the call state is coded as RESTO.

5.8 List of system parameters

The description of timers in the network side and the user side of the interface are specified in clause 9/Q.931.

5.8.1 Timers in the network side

The network side timers are specified in Table 9-1/Q.931. The Timers that are supported in this Recommendation are: T301 T303, T305, T308, T309, T310, T312 and T322.

5.8.2 Timers in the user side

The user side timers are specified in Table 9-2/Q.931. The timers that are supported in this Recommendation are: T301, T303, T305, T308, T309, T310, T313 and T322. Timers T305, T308 and T313 are mandatory for all user side implementations.

Annex A

Additional procedures for Permanent Virtual Connection (PVC) status management (using Unnumbered Information frames)

(This annex forms an integral part of this Recommendation)

This annex describes the means for notification of outage of a Permanent Virtual Connection, and recovery from such a condition. For implementations supporting only PVCs, unacknowledged mode of operation at layer 2 and case A, the procedures given in this annex are applicable. These procedures may be initiated by a user equipment that supports PVCs and only Unnumbered Information (UI) frame transfer only. Optionally, these procedures may be initiated by the network for those networks that implement bidirectional status enquiry. This annex applies only to case A (using in-channel signalling). These procedures are intended to be used only for operational purposes (rather than maintenance and management).

For implementation that requires co-existence of Switched frame mode Virtual Connections (SVC) and Permanent frame mode Virtual Connections on the same interface, the procedures of this annex are also used.

The procedures include:

a) notification of the addition of a PVC;

b) detection of the deletion of a PVC;

c) notification of the availability (active) or unavailability (inactive) state of a configured PVC:

– inactive means that the PVC is configured but is not available to be used;

– active means that the permanent virtual connection is available to be used;

d) link integrity verification.

NOTE – Additional procedures for operation of permanent virtual connections may be a subject of future Recommendations.

The layer 3 messages are transferred across the bearer channel using layer 2 unnumbered information frames (as defined in Recommendation Q.922) on DLCI 0, with the poll bit set to 0. The forward explicit congestion notification, backward explicit congestion notification, and the discard eligibility indicator bits shall be set to 0 on transmission.

A.1 Messages used for PVC status

The messages that use the dummy call reference for permanent virtual connection support in the frame relay service are STATUS and STATUS ENQUIRY. The messages used for PVC status are sent using the dummy call reference (see 4.3/Q.931) on DLCI = 0.

A.1.1 STATUS

This message is sent in response to a STATUS ENQUIRY message to indicate the status of permanent virtual connections or for a link integrity verification. Optionally, it may be sent at any time to indicate the status of a single PVC. See Table A.1.

A.1.2 STATUS ENQUIRY

This message is sent to request the status of permanent virtual connections or to verify link integrity. Sending a STATUS message in response to a STATUS ENQUIRY message is mandatory. See Table A.2

TABLE A.1/Q.933

Message type: STATUS Significance: local	Direction: both			
Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	Both	M	1
Call reference	4.3	Both	M	1
Message type	4.4	Both	M	1
Report type	A.3.1	Both	M	3
Link integrity verification	A.3.2	Both	O (Note 1)	4
PVC status (Note 2)	A.3.3	Both	O (Note 3)	5 – 7 (Note 2)

NOTES

1 Mandatory if the type of report is *full status* or *link integrity verification only*. Not included in the optional asynchronous status message (report type equal to single PVC asynchronous status).

2 Included in the case of a full status message. This is a STATUS message that contains the status of all PVCs on the bearer channel. There is one PVC status information element for each permanent virtual circuit configured on that bearer channel. The PVC status information elements are arranged in the message in ascending order of DLCIs; the PVC with the lowest DLCI is first, the second lowest DLCI is second, and so on. The maximum number of PVCs that can be indicated in a message is limited by the maximum frame size. The optional asynchronous STATUS message contains a single PVC status information element.

3 Mandatory if the report type information element indicated *full status* or *single PVC asynchronous status* and the bearer channel has PVCs configured.

TABLE A.2/Q.933

Messge type: STATUS ENQUIRY Significance: Local	Direction: both			
Information element	Reference	Direction	Type	Length
Protocol discriminator	4.2	Both	M	1
Call reference	4.3	Both	M	1
Message type	4.4	Both	M	1
Report type	A.3.1	Both	M	3
Link integrity verification	A.3.2	Both	M	4

A.2 Information elements

A.2.1 Protocol discriminator

See 4.2/Q.931.

A.2.2 Call reference

The dummy call reference value is used for these procedures. See 4.3/Q.931.

A.2.3 Message type

See 4.4.

A.3 Information elements

A.3.1 Report type

The purpose of the Report type information element is to indicate the type of enquiry requested when included in a STATUS ENQUIRY message or the contents of the STATUS message. The length of this information element is 3 octets. See Figure A.1.

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

Type of report (octet 3)

Bits

8765 4321

0000 0000 Full status (status of all PVCs on the bearer channel)

0000 0001 Link integrity verification only

0000 0010 Single PVC asynchronous status

All other values are reserved.

FIGURE A.1/Q.933

Report type information element

A.3.2 Link integrity verification

The purpose of the link integrity verification information element is to exchange sequence numbers between the network and the user equipment on a periodic basis. The length of this information element is 4 octets. See Figure A.2.

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

Send sequence number (octet 3)

The current send sequence number of the originator of the message. It is binary encoded.

Receive sequence number (octet 4)

The send sequence number received in the last received message. It is binary encoded.

FIGURE A.2/Q.933

Link integrity verification information element

A.3.3 PVC status

The purpose of the PVC status information element is to indicate the status of existing PVCs on the bearer channel. This information element can be repeated, as necessary, in a message to indicate the status of all PVCs on the bearer channel. The length of this information element depends on the length of the DLCIs being used on the channel. The length of this information element is 5 octets when a default address format (2 octet) is used. See Figure A.3.

NOTE – Support of single PVC status is for further study.

8	7	6	5	4	3	2	1	Octet
0	PVC status 1	0	1	0	1	1	1	1 Information element identifier
Length of PVC status contents								2
0 ext.	0 Spare	Data link connection identifier (Most significant 6 bits)						3 (Note 1)
1 ext.	Data link connection identifier (2nd most significant 4 bits)				0	0 Spare	0	3a (Note 2)
1 ext.	0	0 Spare	0	New	Delete	Active	0 Reserved	4

NOTE 1 – Bit 6 of octet 3 is the most significant bit in the data link connection identifier.

NOTE 2 – When address extension octets are implemented, the structure (octets 3b and 3c) given in Figure 4-3 apply.

Data link connection identifier (octet 3 bits 6-1 and 3a bits 7-4)

Data link connection identifier is coded in binary.

New (octet 4)

Bit

4

0 PVC is already present

1 PVC is new

NOTE 3 – This bit has no significance in a single PVC asynchronous status.

Delete (octet 4)

Bit

3

0 PVC is configured

1 PVC is deleted

NOTE 4 – The delete bit is only applicable for timely notification using the optional single PVC asynchronous status report.

NOTE 5 – When this bit is set to "1", the new and active bits have no significance and shall be set to zero. The delete bit shall be set to "0" when the new or active bits have significance and are set to "1".

Active (octet 4)

Bit

2

0 PVC is inactive

1 PVC is active

NOTE 6 – If the A bit is set to zero in a PVC status information element, the end user should stop using the specified PVC. The network sets this bit to zero when the network determines that the PVC is not operational.

FIGURE A.3/Q.933

PVC status information element for default 2-octet address

A.4 Procedures

These procedures use periodic polling to determine the status of PVC connections and to verify the integrity of the link.

A.4.1 Periodic polling

The user equipment initiates the polling described below. In the optional case where the procedures are initiated by the network, similar procedures apply with administration of sequence numbers as indicated in A.6.

If bidirectional procedures are implemented by the network, the network shall use STATUS ENQUIRY messages, and users shall respond with STATUS messages, as specified in these procedures.

1) Every T391 seconds, the user equipment sends a STATUS ENQUIRY message to the network and resets its polling timer (T391). The T391 interval between such messages is called the polling interval.

2) The STATUS ENQUIRY message typically requests a link integrity verification exchange only, (report type equal "0000 00001"). Every N391 polling cycles, the user equipment requests full status of all PVCs (report type equal "0000 0000").

3) The network responds to each STATUS ENQUIRY message with a STATUS message and resets the T392 timer, which is used by the network to detect errors (see A.5). If the STATUS ENQUIRY requests full status, it must be responded to with a STATUS message with the type of report specifying full status. The STATUS message sent in response to a STATUS ENQUIRY contains the link integrity verification and report type information elements. If the content of the report type information element specifies *full status*, then the STATUS message must contain one PVC status information element for each PVC configured on the bearer channel.

4) The user equipment shall parse the STATUS message depending upon the type of report. The network may respond to any poll with a full status message in case of a PVC status change or to report a newly added PVC on the bearer channel. If it is a full status message, the user equipment should update the status of each configured PVC.

5) The user equipment shall interpret the omission of a previously reported PVC from the full status message as an indication that the PVC is no longer provisioned for the bearer channel.

NOTE – The optional single PVC asynchronous STATUS message is not part of the periodic polling process.

A.4.2 Link integrity verification

The purpose of the link integrity verification information element is to allow the network and the user equipment to determine the status of the in-channel signalling link (DLCI 0). This is necessary since these procedures use unnumbered information (UI) frames at layer 2.

The user and the network maintain the following internal counters:

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

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

The following procedure is used:

1) Before any messages are exchanged, the network and the user device set the send sequence counter and receive sequence counter to zero.

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

3) When the network receives a STATUS ENQUIRY from the user equipment, the network checks the receive sequence number received from the user equipment against its send sequence counter. The handling of error conditions is described in A.5.

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

4) When the user equipment receives a STATUS from the network in response to a STATUS ENQUIRY, the user equipment checks the receive sequence number received from the network against its send sequence counter. The handling of error conditions is described in A.5. The received send sequence number is stored in the receive sequence counter.

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

A.4.3 Reporting new PVCs

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

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

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

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

NOTE – The procedures for reporting of new PVCs are not supported by asynchronous status messages.

A.4.4 Reporting the availability of a PVC

The user equipment uses the PVC status message to detect a change in status of configured PVCs. As described in A.4.1, every N391 polling interval the user equipment sends a STATUS ENQUIRY message with a report type of full status. The network responds with a STATUS message containing a PVC status information element for each PVC configured on that bearer channel. Each PVC status information element contains an active bit indicating the availability or unavailability of that PVC.

The action of the user equipment based on the value of the active bit is independent of the action based on the new bit. The user equipment could get a PVC status information element with the new bit set to 1 and the active bit set to 0.

If the user equipment receives a PVC status information element with the active bit set to 0, the user equipment shall stop transmitting frames on the PVC until it receives a PVC status information element for that PVC with the active bit set to 1. Other action taken by the user equipment is implementation dependent.

Since there is a delay between the time the network makes a PVC available and the time it transmits a PVC status information element notifying the user equipment, there is a possibility of the user equipment receiving frames on a PVC marked as unavailable. The action the user equipment takes on receipt of frames on an unavailable PVC is implementation dependent.

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

See the following subclause for conditions under which the network sets the active bit to zero.

A.5 Error conditions

The frame relay network and the user equipment use the information provided by periodic polling for error monitoring. The network and user equipment detect the following error conditions:

- In-channel signalling link (DLCI 0) reliability errors (i.e. non-receipt of STATUS/STATUS ENQUIRY messages or invalid sequence numbers in a link integrity verification information element).

- Signalling link protocol errors. See 5.7 (i.e. protocol discriminator, message type, call reference and mandatory information element errors). Ignore messages (including their sequence numbers) containing these errors.

NOTE – If the user or network were to count an error once when receiving a message that it does not recognize, and a second time for non-receipt of a STATUS or STATUS ENQUIRY message, the user or network would have counted the same error twice, inflating the user or network error counts. No errors should be counted in this case.

Errors are detected as anomalies in the timing or content of events.

The network and user equipment can also detect and act on errors not described in this subclause (e.g. layer 1 errors, frame check sequence errors, and protocol errors with each PVC).

A.5.1 Network operation errors

The network shall set the active bit to 0 if it detects a service affecting condition within the network (not defined here).

The network increments the error count when any of the following reliability errors are encountered:

- Non-receipt of a STATUS ENQUIRY within T392, which results in restarting T392.

- Invalid contents of a link integrity verification information element. This consists of an invalid receive sequence number. The received receive sequence number is not valid when it is not equal to the last transmitted send sequence number. Follow the procedures in A.4.2, paragraph 2 (as a result, the receive send sequence number is processed, allowing the user to accept the STATUS message. Note that the error count is incremented). Reply with the requested type of report and restart T392.

When a signalling link protocol error occurs, the user ignores the entire message. As a result, T391 expires and the user increments the error count.

A.5.2 User equipment operation errors

The user equipment detects the following errors at the user-to-network interface:

- On receipt of a STATUS message with type of report set to link integrity verification in response to a STATUS ENQUIRY message with type of report set to full status, the message is ignored. When timer T391 expires, the user increments the error count.

- Upon receipt of an unsolicited STATUS message with type of report set to full status or link integrity verification, the message shall be ignored, and the error count shall be incremented.

- Non-receipt of a STATUS message with type of report equal to full status or link integrity verification in a polling interval (within T391 seconds) after transmission of a STATUS ENQUIRY. When timer T391 expires, increment the error count.

  NOTE 1 – If the unanswered STATUS ENQUIRY requested full status, the user equipment shall again request full status.

- Invalid contents of a link integrity verification information element. This consists of detecting an invalid receive sequence number. The received receive sequence number is not valid if it is not equal to the last transmitted send sequence number. Ignore messages containing this error. As a result, timer T391 expires and the user then increments the error count.

  NOTE 2 – Using the send sequence number of a STATUS message containing an invalid receive sequence number may cause the user to acknowledge a STATUS message containing a full status report that has been ignored (i.e. acknowledgment of the new bit and deletion status).

NOTE 3 – Asynchronous status messages do not satisfy the requirement for a STATUS message in a given polling interval.

In addition to the above error conditions, when a signalling link protocol error occurs, the user ignores the entire message. As a result, T391 expires and the user increments the error count.

The loss of a frame at layer 2 (e.g. CRC error) will be detected by non-receipt of a STATUS or STATUS ENQUIRY.

An event is defined as transmission of a STATUS ENQUIRY message.

Following the detection of a service affecting condition at the user-network interface, the user equipment should stop transmission of frames on all PVCs on the bearer channel. The user equipment should continue link verification procedures to detect service restoration. One method of determining a service affecting condition is by detecting N392 errors in the last N393 events. The user equipment also may use other methods for detecting service affecting conditions.

When the user equipment detects that the service affecting condition is cleared, it resumes normal operation of active PVCs on the bearer channel. One method to detect service restoration is by detecting that N392 consecutive events have occurred without error.

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

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

If the user equipment receives a full status STATUS message from the network that is missing a PVC status information element for a PVC that the user equipment currently is using, the user equipment shall remove that PVC from its list of PVCs.

A.6 Optional bidirectional network procedures

Bidirectional procedures at the UNI are optional for both the user and network. Use of these procedures must be bilaterally agreed between user and network.

Bidirectional procedures mean that there is symmetrical operation on the bearer channel where both the “user side” procedures and “network side” procedures defined in Annex A are operating concurrently on each end of the bearer channel.

Two sets of local in-channel signalling parameters are administered for a given bearer channel as shown below:

- User side procedures – T391, N391, N392 and N393.
- Network side procedures – T392, N392 and N393.

One set of parameters is used when the network or user equipment is providing the “user side procedures” which sends the polling messages (status enquiries). The other set of parameters is used when the network or user equipment is providing the “network side procedures” which sends a response (status message) to each polling message.

Both ends of the bearer channel are required to initiate STATUS ENQUIRY messages based on T391. A full status report is requested every N391 (default 6) polling cycles. This periodic polling process is described in A.4.1 and A.4.2.

When it is first activated, the user equipment (or network) shall consider the bearer channel to be non-operational. When the user equipment (or network) observes one of the following events on the bearer channel, it shall consider that bearer channel to be operational:

- N393 consecutive valid polling cycles occur.
- As an alternative, one valid polling cycle occurs. That is, if the first polling cycle constitutes a valid exchange of sequence numbers, then the bearer channel shall be considered operational. If the first polling cycle results in an error, then the bearer channel shall be considered non-operational until N393 consecutive valid polling cycles occur at the local interface.

Later (after it has once been considered operational), the bearer channel is considered non-operational following detection of a service affecting condition (see A.5) at the user-to-network interface, and it is considered operational following detection of service restoration.

The network shall report a PVC as "active" to the local user (i.e. active bit = 1) only if all the following criteria are met:

1) The PVC is configured in the network.

2) The network considers the bearer channel to be operational, as specified above.

3) The PVC is operational within the network (i.e. no service affecting condition exists within the network or at the remote user-to-network interface).

4) The remote user, when required to support bidirectional procedures, reports that the PVC is active by setting the active bit = 1 in a PVC status information element.

Whenever these criteria are not fully met, the PVC status information element active bit indication shall be set to 0.

The PVC status information element active bit indication sent by a user shall be propagated by the network towards the remote user associated with the PVC (in conjunction with the four points defined above).

The presence or absence of a PVC status information element in a full status report sent by a user indicates the presence or absence of the user's DLCI within the bearer channel.

A full status report sent by the user must contain one PVC status information element for each PVC configured by the user equipment on the bearer channel. The network shall update the active status of each PVC configured by the network on the bearer channel, and shall interpret the omission of a previously reported PVC from the full status report as an indication that the PVC is no longer configured by the user equipment on the bearer channel. Removal of a PVC configuration by the user does not necessarily cause the network or the remote user to remove its configuration.

If the network detects that a user has deleted a PVC status information element from a full status report, then an inactive status is propagated by the network to the remote user associated with the PVC (i.e. the PVC status information element active bit indication is set to 0).

The network operation error conditions described in A.5.1 apply to the network side procedures. The user equipment operation errors described in A.5.2 apply to the user side procedures.

A.7 System parameters

Tables A.3 and A.4 summarize the acceptable values for the configurable parameters described in these procedures. Parameter values other than the default values are a subscription option.

TABLE A.3/Q.933

System parameters – counters

Counter	Description	Range	Default	Usage	User or Network
N391	Full status (status of all PVCs) polling counter	1-255	6	Polling cycles	User and network (Note 3)
N392	Error Threshold	1-10 (Note 1)	3	Errors	Both
N393	Monitored events count	1-10 (Note 2)	4	Events	Both

NOTES

1 N392 should be less than or equal to N393.

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

3 N391 always applies to the user equipment. It applies to the user and network if the optional bidirectional network procedures are invoked (see A.6).

TABLE A.4/Q.933

System parameters – timers

Timer	Description	Range (seconds)	Default (seconds)	Started	Stopped	Actions taken when expired
T391 (Note 2)	Link integrity verification polling timer	5-30	10	Transmit STATUS ENQUIRY	–	Transmit STATUS ENQUIRY. Record error if STATUS message not received
T392 (Note 3)	Polling verification timer	5-30 (Note 1)	15	Transmit STATUS	Receive STATUS ENQUIRY	Record error by incrementing N392. Restart

NOTES

1 T392 should be greater than T391.

2 T391 always applies to the user. It applies to the user and network if the optional bidirectional network procedures are invoked (see A.6).

3 T392 always applies to the network. It applies to the network and user equipment if the optional bidirectional network procedures are invoked (see A.6).

A.8 Annex A SDL specification

These SDLs are intended to complement, not replace or substitute the narrative description contained in A.1 and A.7. Should any discrepancy arise, the text from A.1 to A.7 shall take precedence.

NOTE – The following is a summary of the abbreviations used in the SDLs.

The two sides of communication are called A and B respectively. A is the User side and B is the Network side.

For the case of Annex A/Q.933 bidirectional procedures, both A and B sides of the interface implement the polling (Enquiry) and polled (Response) procedures of this Annex A/Q.933.

The following naming conventions are used:

Ae	A side using Enquiry (e) message.
Br	B side replies with Status Response message (r).
SndSeqCnt	Send Sequence Counter.
RevSeqCnt	Receive Sequence Counter.
SE	Status Enquiry message.
S	Status message.
RT	The Report Type in SE or S messages.
LIV	The Link Integrity Verification Information Element in SE or S messages.
LIV.ssn	The field of send sequence number in LIV.
LIV.rsn	The field of receive sequence number in LIV.

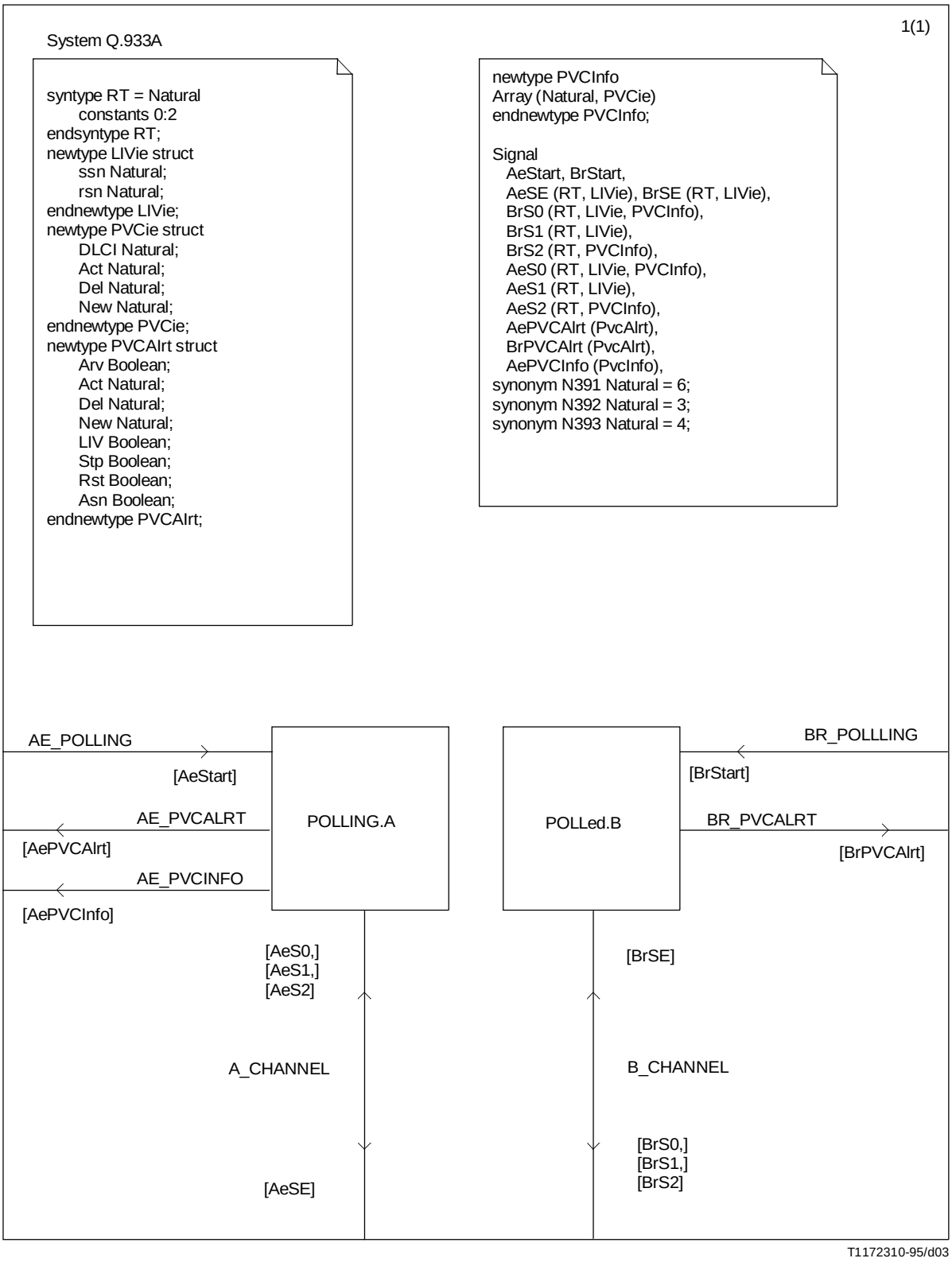


FIGURE A.4/Q.933

System Q.933A

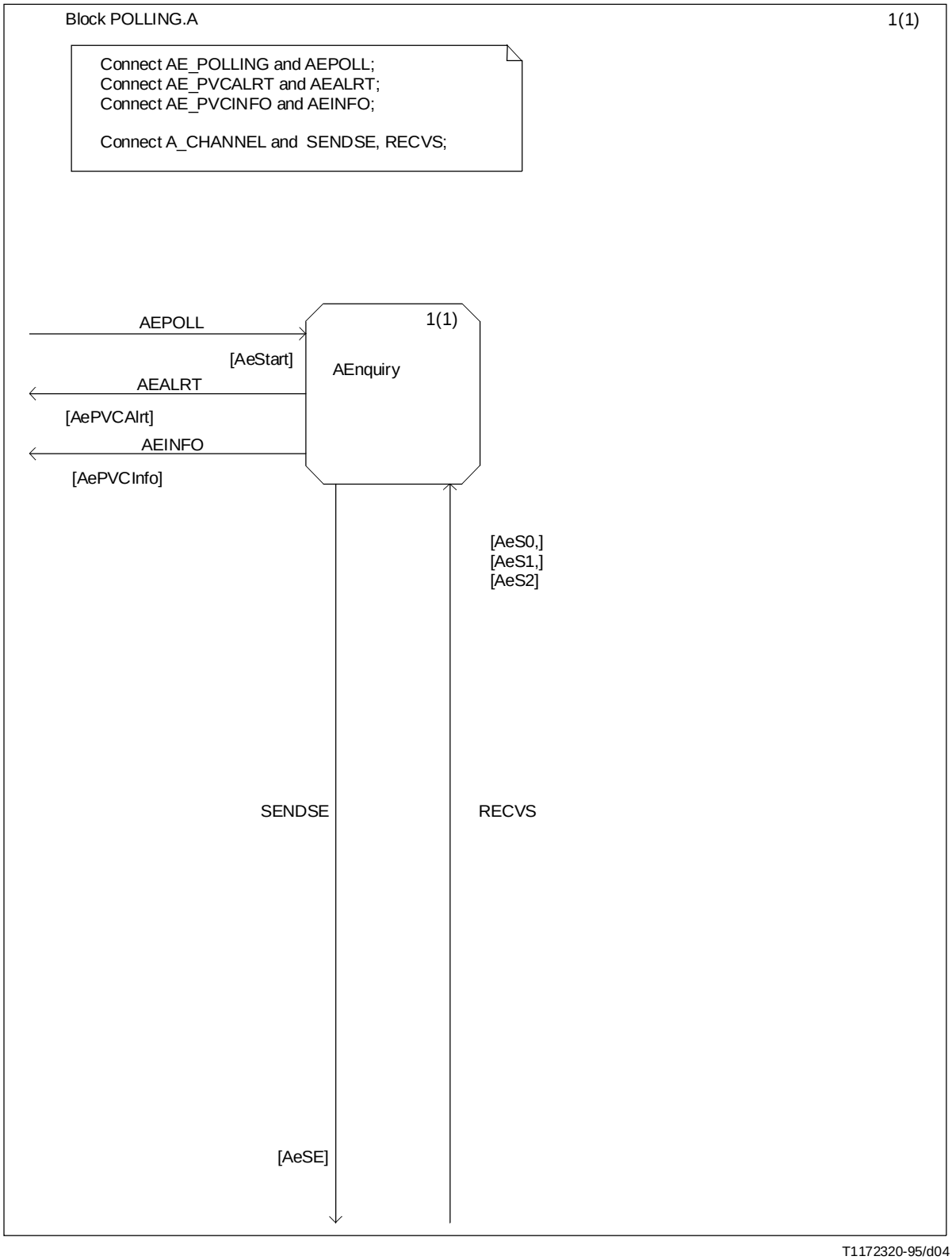


FIGURE A.5/Q.933

Block POLLING.A

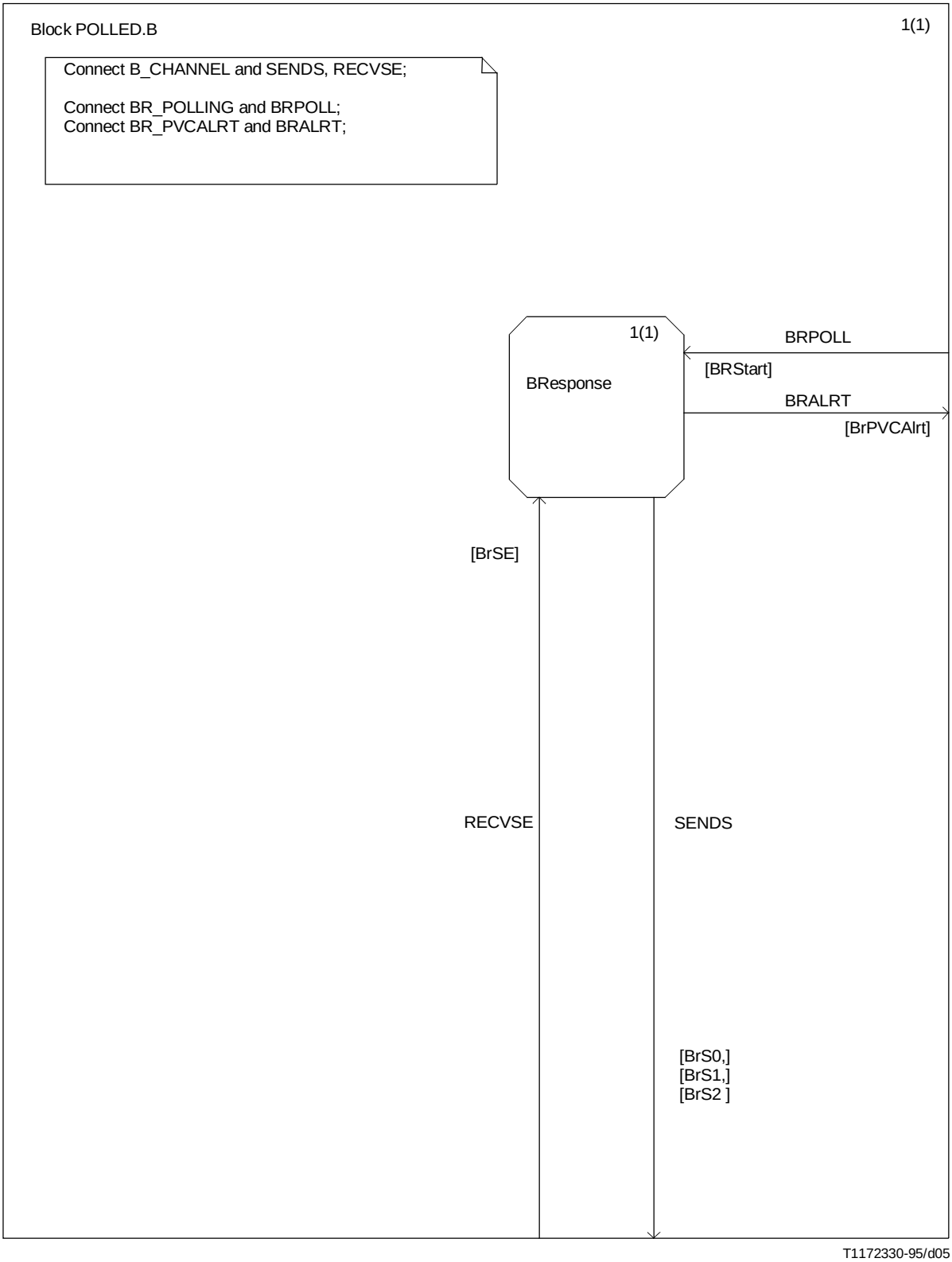


FIGURE A.6/Q.933

Block POLLED.B

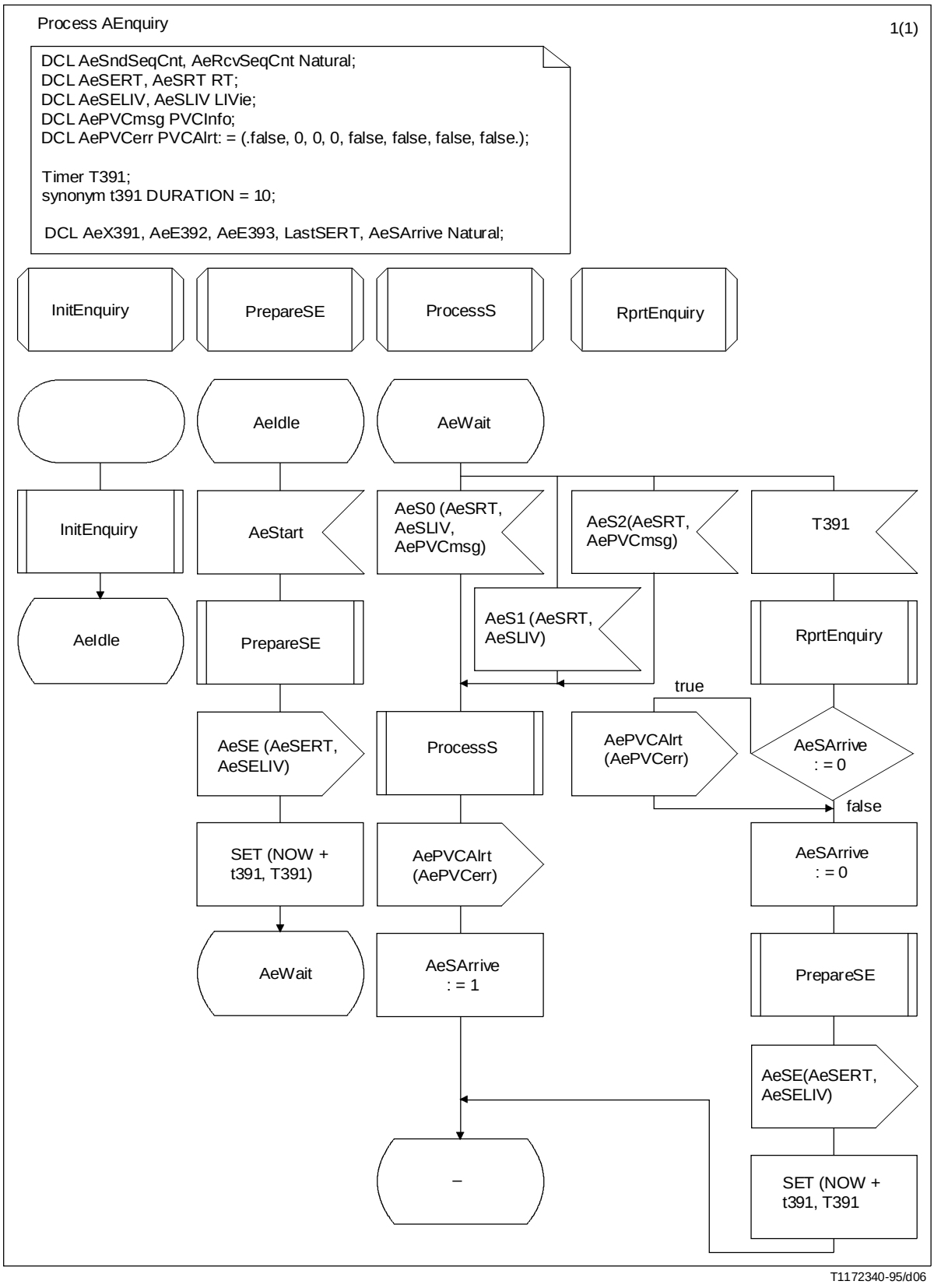


FIGURE A.7/Q.933

Process AEnquiry

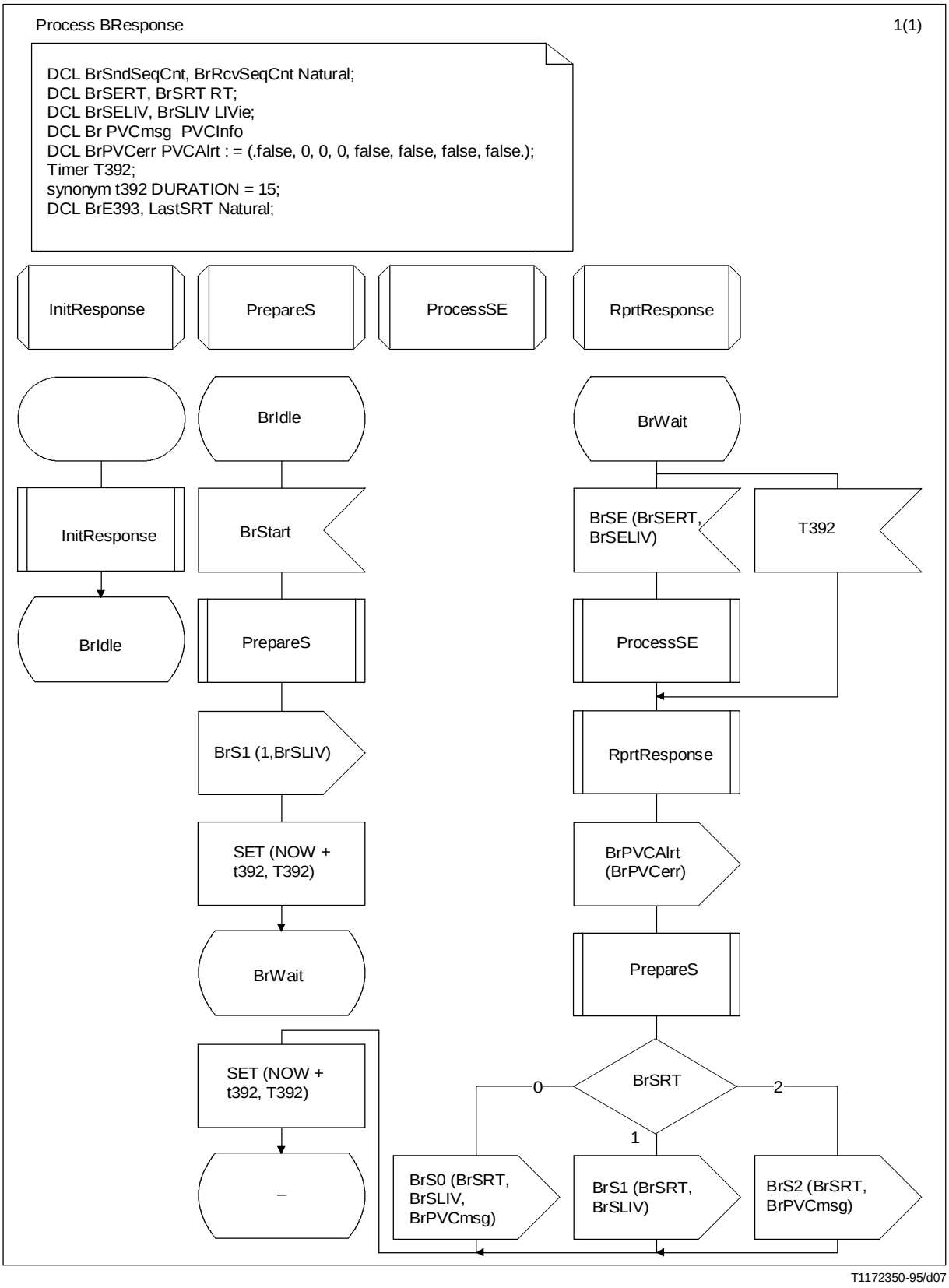


FIGURE A.8/Q.933

Process BResponse

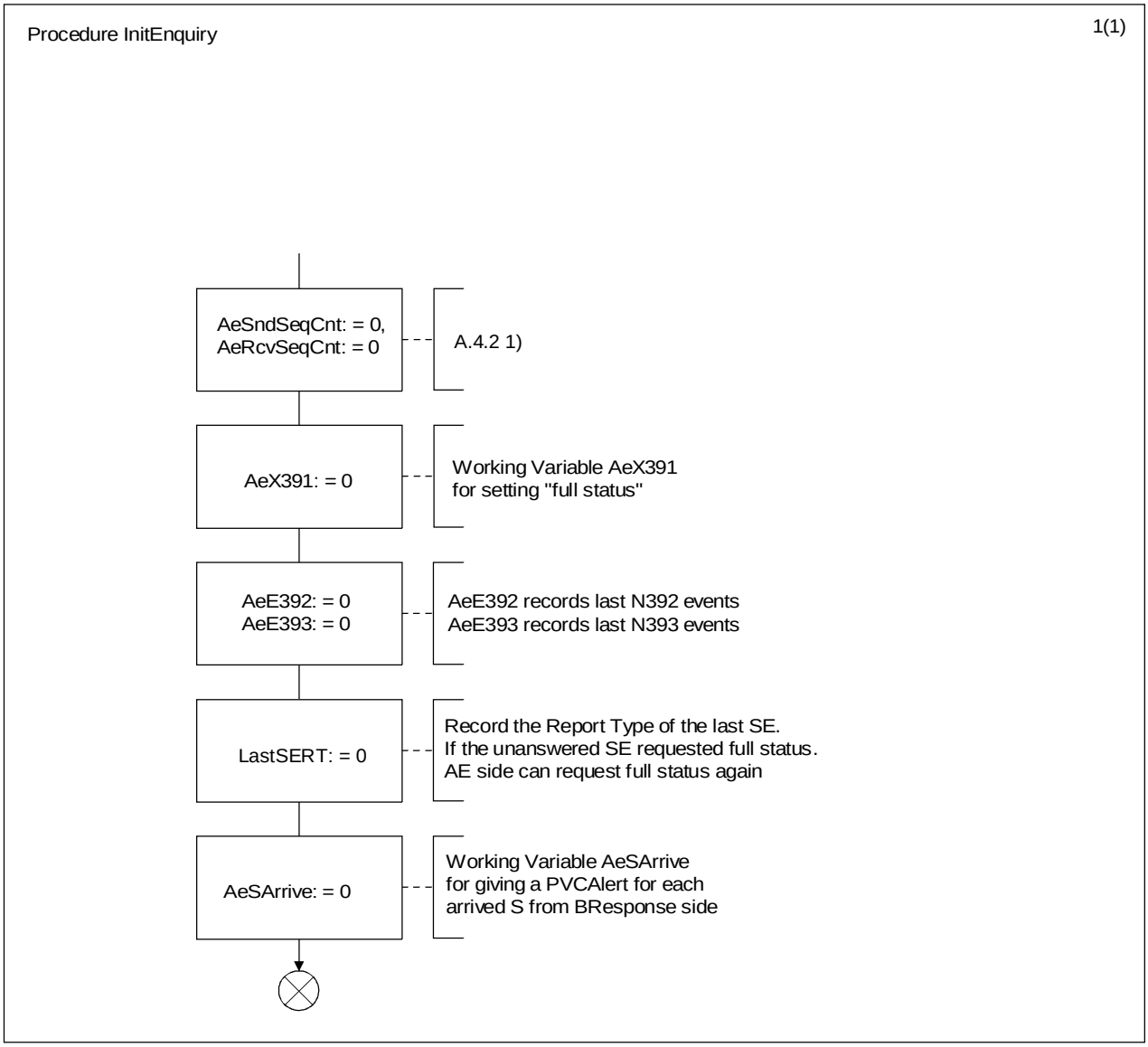


FIGURE A.9/Q.933

Procedure InitEnquiry

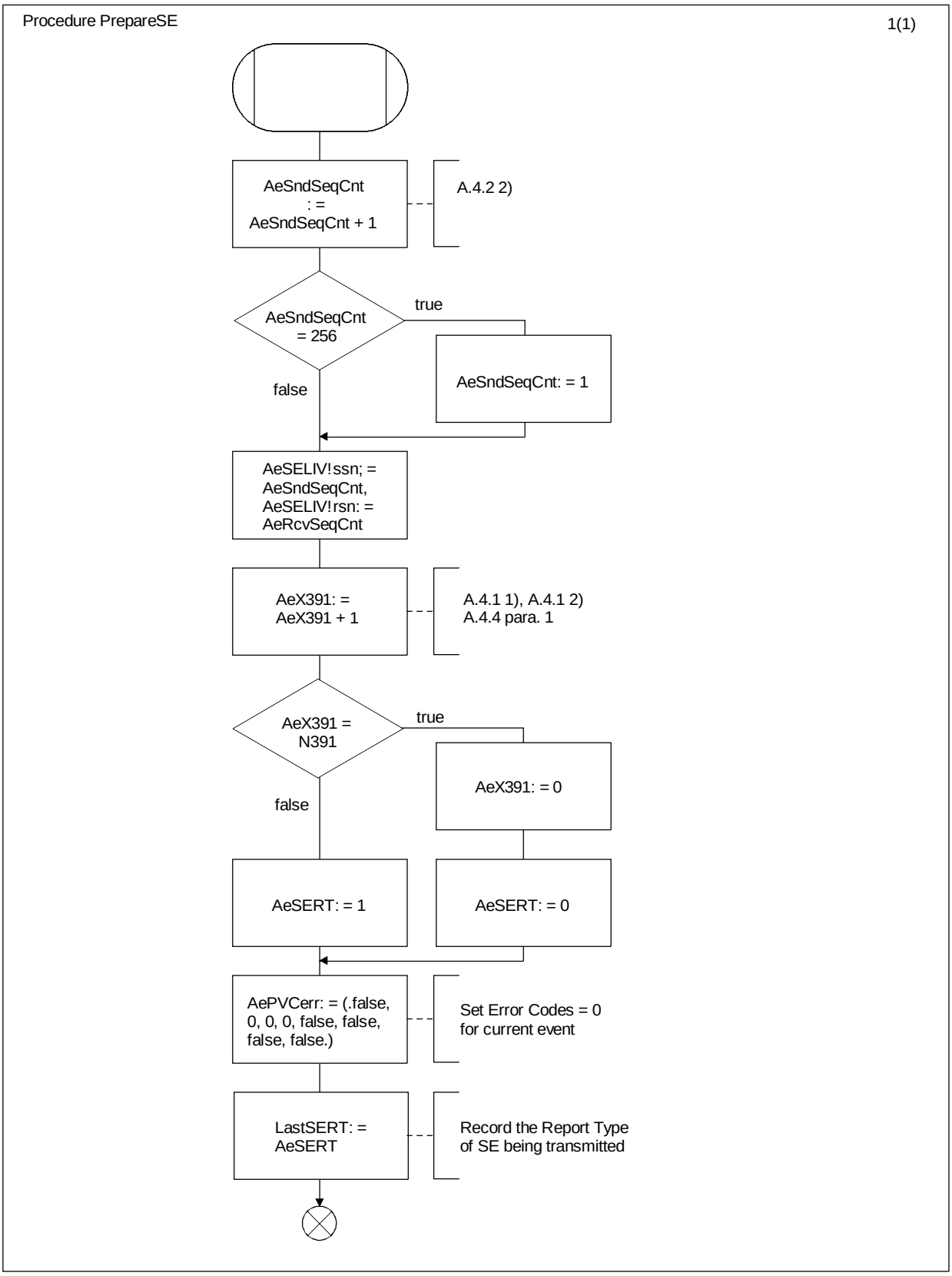


FIGURE A.10/Q.933

Procedure PrepareSE

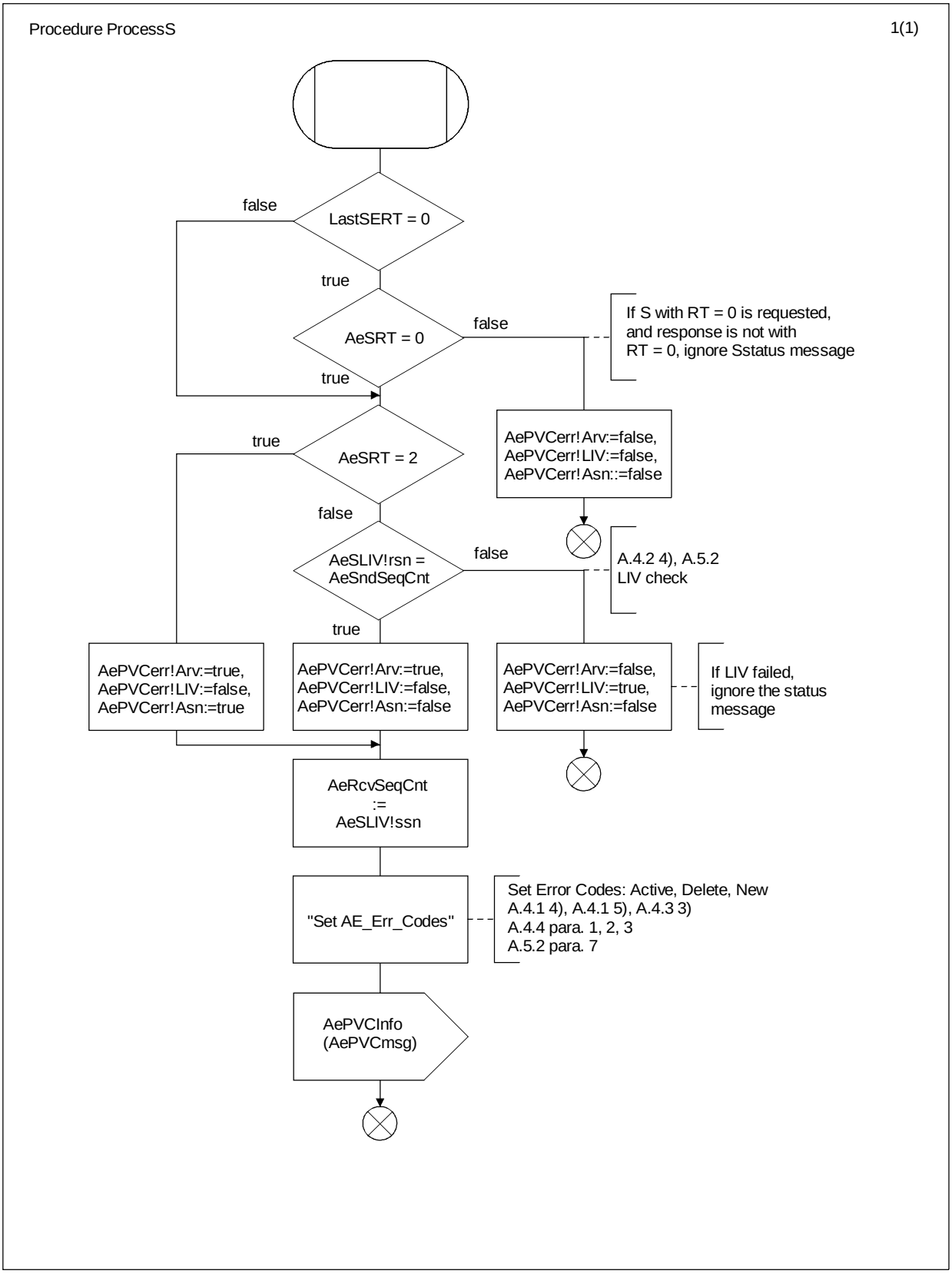


FIGURE A.11/Q.933

Procedure ProcessS

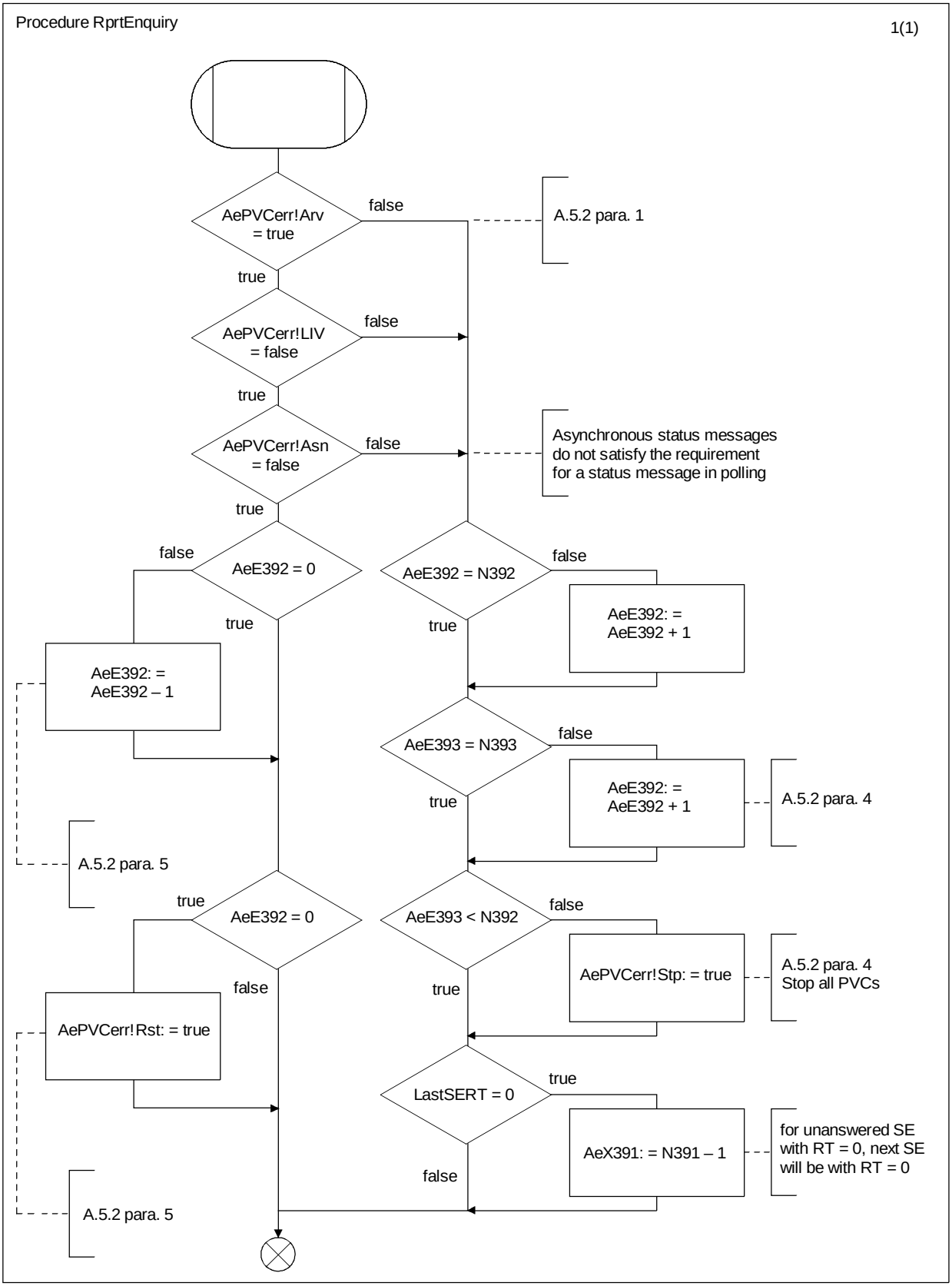


FIGURE A.12/Q.933

Procedure RprtEnquiry

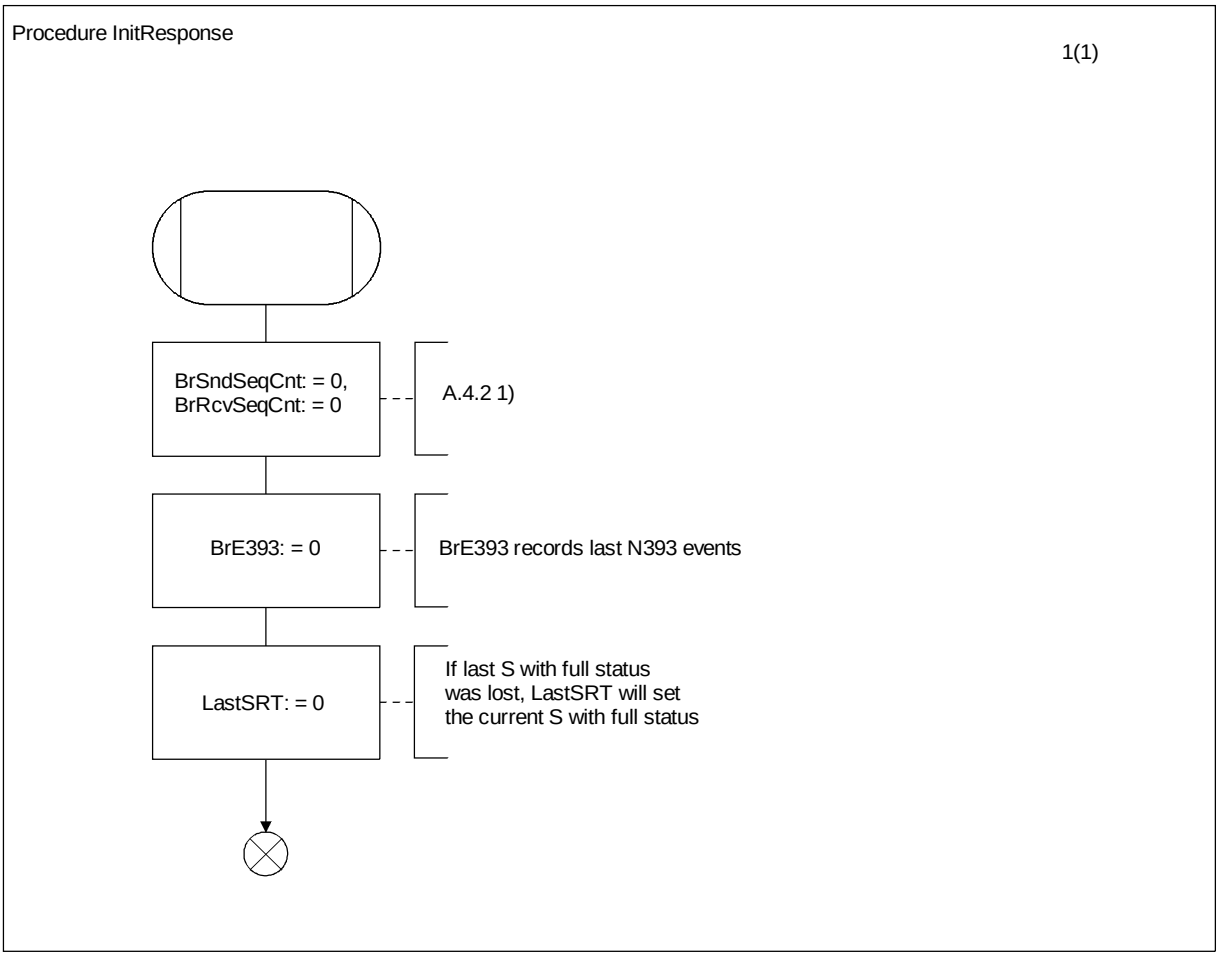


FIGURE A.13/Q.933

Procedure InitResponse

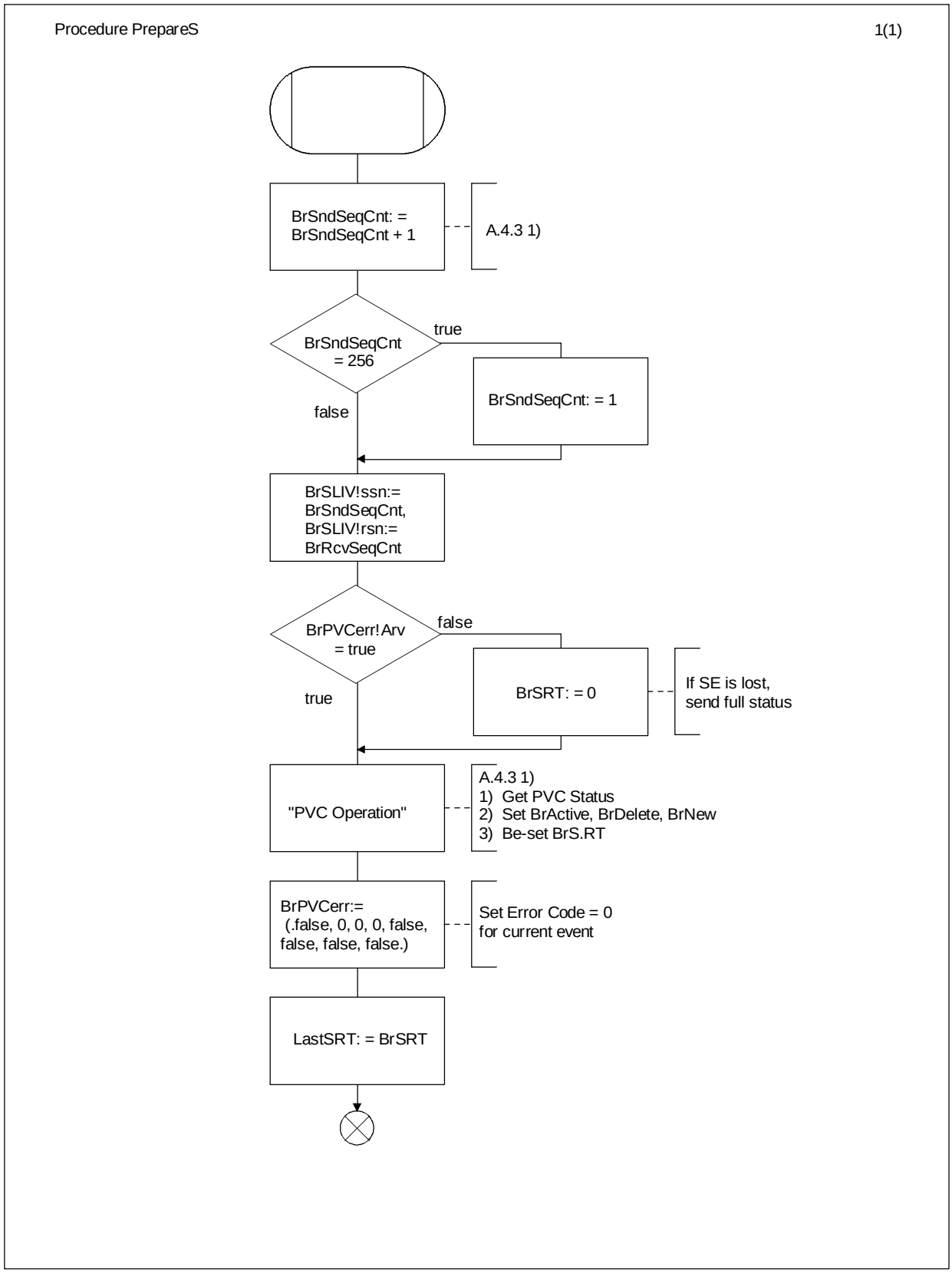


FIGURE A.14/Q.933

Procedure PrepareS

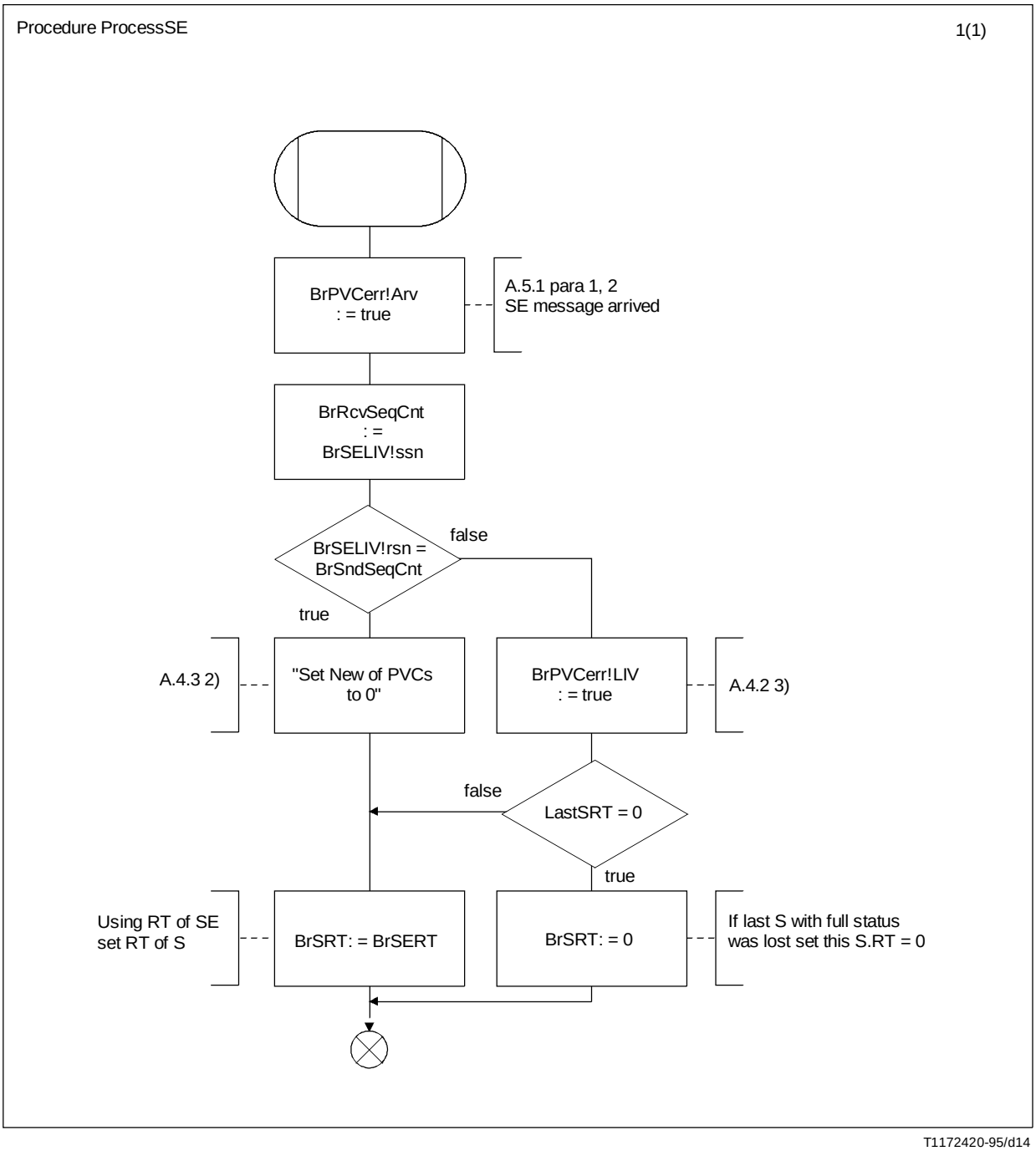


FIGURE A.15/Q.933

Procedure ProcessSE

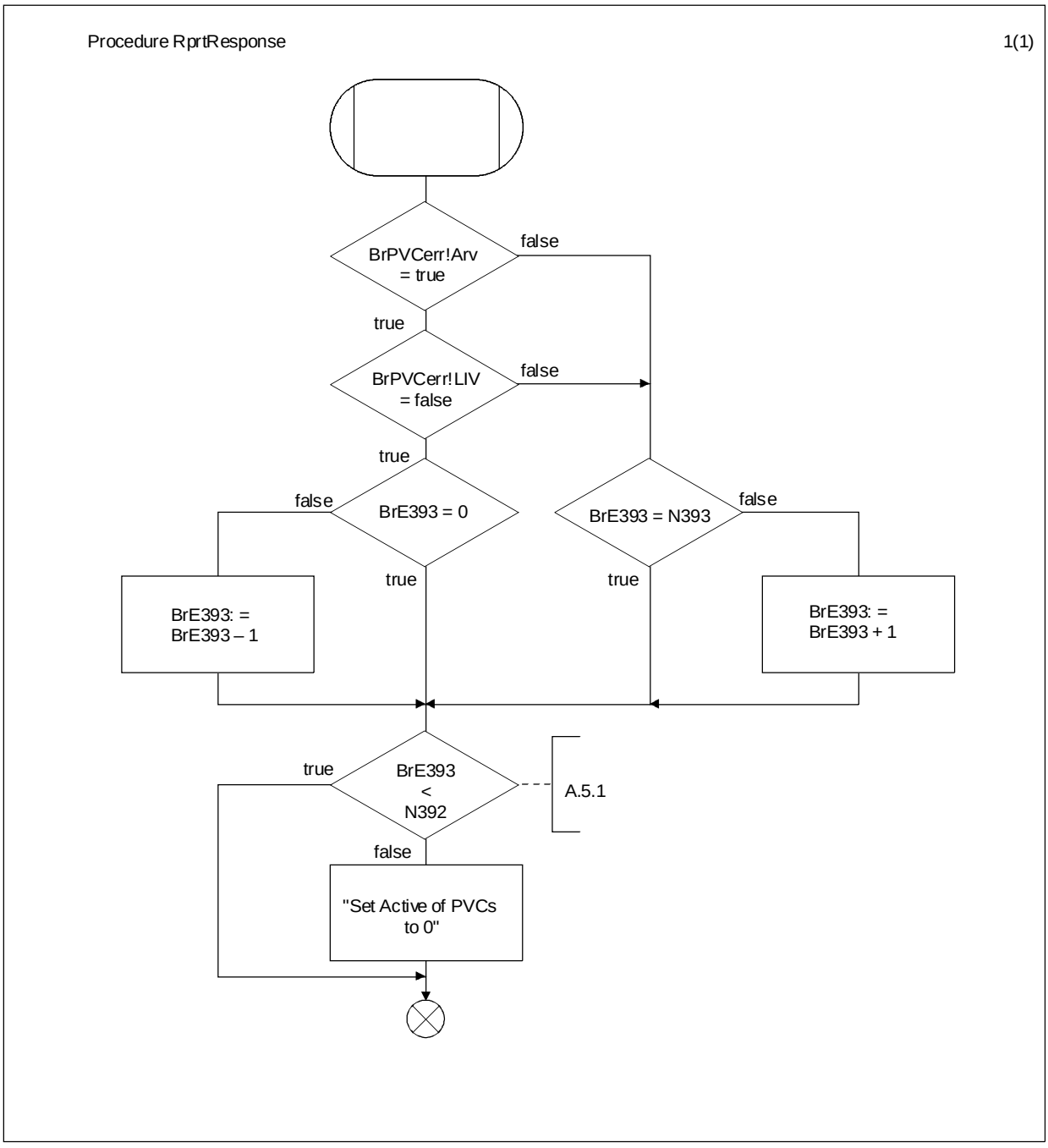


FIGURE A.16/Q.933

Procedure RprtResponse

Annex B

Additional procedures for permanent frame mode connection using acknowledged mode of operation

(This annex in Recommendation Q.933 (1993) has been deleted and is no longer part of this Recommendation)

Annex C

Provision of OSI connection mode network services (NC-establishment and release phases)

(This annex forms an integral part of this Recommendation)

Support of OSI connection mode network services is optional. It allows this Recommendation to be used in conjunction with a Network Layer data transfer phase protocol, i.e. either Appendix IV/Q.922 or X.25 Data Transfer Phase to provide and support the CONS and is applicable only in this case. Alternatively, the CONS may be provided and supported over Frame-mode bearer services by use of the X.25 Packet-layer protocols according to the procedures specified in Recommendation X.223; in this case, the procedures of this annex do not apply.

This annex defines one of the methods for supporting the network-layer connection establishment and release phases of the OSI connection-mode network service (CONS) through the use of the procedures of this Recommendation.

The relationship between this Recommendation and the network-layer connection establishment and release phases of the OSI CONS is shown in Figure C.1. This relationship is described only in terms of the network layer entities that provide the CONS (i.e. in a TE1 functional group), and no description is made of the actions of a network layer entity which performs only a relay function for a given N-Connection (i.e. as in an ET, NT2 or TA functional group).

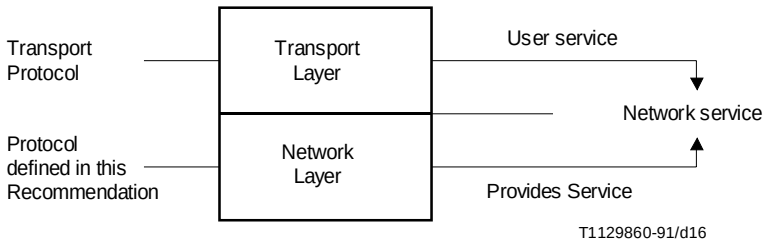


FIGURE C.1/Q.933

Relationship between this Recommendation and the NC-establishment and release phases of the OSI CONS

C.1 Definitions

The following terms, developed in the OSI Reference Model (see Recommendation X.200) are used:

- Network connection;
- Network layer;
- Network service;
- Network Service Access Point (NSAP);
- Network service access point address;
- Sub-network.

The following terms, as they apply to the network layer and as defined in the OSI layer service conventions (see Recommendation X.210), are used:

- Network service user (NS-user);
- Network service provider;
- Primitive;
- request;
- indication;
- response;
- confirm.

The following terms, as defined in the OSI Network Service (see Recommendation X.213) are used:

- Calling network service user;
- Called network service user;
- Network Protocol Address Information (NPAI).

The following term, as defined in the Internal Organization of the Network Layer (ISO/IEC 8648) is used:

- Sub-Network Dependent Convergence Protocol (SNDCP).

C.2 Overview

The OSI CONS provides for the transfer of data between NS-users. It makes invisible to the NS-users the way in which supporting communications resources are utilized to achieve this transfer.

This annex may be used to support a specific realization of the NC-establishment and release phases of the CONS. The elements of the protocol to be considered are:

a) the messages and information elements to be mapped to the primitives and parameters in support of the OSI CONS;

b) the relevant procedures in support of the frame mode bearer service; and

c) the supplementary services required in support of the CONS.

In addition to the frame mode bearer service, the following supplementary services shall be used and/or subscribed:

1) Calling Line Identification Presentation (CLIP);

2) Connected Line Identification Presentation (COLP);

3) Sub-address (used except where the NSAP address can be encoded entirely in the Called party number, Calling party number and Connected party number information elements);

4) User-user signalling, service 1 (implicit) (used to provide the NS-user data parameter to the N-CONNECT request or N-DISCONNECT request primitive, and subscribed except if there is *a priori* knowledge that the NS-User will never supply the NS-user data parameter).

Other supplementary services may also be used and/or subscribed.

The NS-provider (and, specifically, the NL entity in an end system) provides:

- in the NC-establishment and release phases, a translation between the primitives and parameters of the OSI CONS and the messages and lEs of this Recommendation;
- in the data transfer phase, a translation between the primitives and parameters of the OSI CONS and the packets and associated fields of the Sub-network Dependent Convergence Protocol (SNDCP) agreed between the peer NL entities;
- a Coordination Function (CF), to coordinate the respective operation of the Q.933 protocol and the SNDCP.

NOTE – Study Group 13 is refining the ISDN protocol reference model (see Recommendation I.320) to provide for a Synchronization and Coordination Function (SCF).

C.3 Network connection establishment phase

Table C.1 shows the relationship between the C-plane OSI CONS primitives/parameters used during the network connection establishment phase and the messages and Information Elements (IE) associated with the establishment of an ISDN call.

TABLE C.1/Q.933

Mapping of OSI-CONS to Q.933 for connection establishment phase

OSI-CONS	Rec. Q.933
Primitives:	Messages:
N-CONNECTrequest	SETUP (U → N)
N-CONNECTindication	SETUP (N → U)
N-CONNECTresponse	CONNECT (U → N)
N-CONNECTconfirm	CONNECT (N → U)
Parameters:	Information elements:
Called address	Called party number (Note 1) Called party sub-address (Note 1)
Calling address	Calling party number (Note 1) Calling party sub-address (Note 1)
Responding address	Connected party number (Note 1) Connected party sub-address (Note 1)
Receipt confirmation selection	Packet layer binary parameters
Expedited data selection	Packet layer binary parameters
QOS parameter set: Throughput Transit delay Protection Priority	 Link layer core parameters End-to-end transit delay (Note 2) (X.213 priority)
NS-User-Data	User-user

NOTES

1 Depending on a variety of factors, an NSAP address might be totally encoded in a Called party number information element, totally encoded in a Called party sub-address information element or encoded partially in a Called party Number information element and partially in a Called party sub-address information element. See Recommendation I.334.

2 For further study.

C.3.1 Primitive/Message mapping

On receipt of an N-CONNECT request primitive from a calling NS-user, the NL entity maps the OSI-CONS parameters to the corresponding Q.933 information elements and sends a SETUP message across the ISDN user-network interface.

On receipt of the SETUP message, the NL entity in the remote end system maps the Q.933 information elements to the corresponding parameters, substituting the default values if necessary, and signals an N-CONNECT indication primitive to the NS-user.

If the called NS-user intends to accept the N-connection, it sends an N-CONNECT response primitive to the called NL entity. The called NL entity then maps the OSI-CONS parameters to the corresponding Q.933 information elements and sends a CONNECT message across the ISDN user-network interface. On receipt of the CONNECT message, the NL entity maps the Q.933 information elements to corresponding OSI-CONS parameters and signals an N-CONNECT confirm primitive to the NS-user.

C.3.2 NSAP addresses

Local operation determines the contents of the Network Protocol Address Information (NPAI). When Network Service Access Point (NSAP) addresses are explicitly supplied by the NS-User, they are mapped to and from the corresponding Q.933 information elements. This mapping is done four times.

1) The calling NSAP address parameter in the N-CONNECT request primitive is mapped to the calling party number and/or calling party sub-address information elements (see Recommendation I.334) in the SETUP message (U $\rightarrow$ N). The called NSAP address parameter in the N-CONNECT request primitive is mapped to the called party number and/or called party sub-address information elements (see Recommendation I.334) in the SETUP message.

2) The called party number and/or called party sub-address (see Recommendation I.334) in the SETUP message (N $\rightarrow$ U) are mapped to the called NSAP address parameter in the N-CONNECT indication primitive. The calling party number and/or calling party sub-address (see Recommendation I.334) in the SETUP message are mapped to the calling NSAP address parameter in the N-CONNECT indication primitive.

3) If the responding NSAP address parameter in the N-CONNECT response primitive is not the same as the corresponding called NSAP address presented to the called NS-user in the N-CONNECT indication primitive, it is mapped to the connected party number and/or connected party sub-address information elements (see Recommendation I.334) in the CONNECT message (U $\rightarrow$ N).

4) The connected party number and/or connected party sub-address information elements (see Recommendation I.334) in the CONNECT message (N $\rightarrow$ U), if present, are mapped to the responding NSAP address parameter in the N-CONNECT confirm primitive; if these lEs are not present the responding NSAP address parameter is the same as the called NSAP address parameter in the corresponding N-CONNECT request primitive.

The relationship between NSAP addresses and Q.933 information elements is defined in Recommendation I.334.

C.3.3 QOS parameter set

The set of Quality of Service (QOS) parameters that are conveyed during the establishment phase are:

1) transit delay (which applies to both directions of data transfer);

2) throughput in the direction from calling NS user to the called NS user; and

3) throughput in the direction from the called NS user to the calling NS user;

4) priority to gain an NC;

5) priority to retain an NC;

6) priority of data on the NC;

   NOTE – The following parameter may be the subject of future standardization.

7) protection of data on the NC.

For each of these parameters, a set of "sub-parameters" are defined as follows:

- a target value which is the QOS value requested by the calling NS user;
- a "lowest quality acceptable" value that the calling NS user will agree to;
- an "available" value which is the QOS value that the NS provider agrees to provide; and
- a "selected" value which is the QOS value that the called NS user agrees to use.

The set of values that can be specified for each sub-parameter is defined in 4.5. This set includes the value "unspecified" and may also include a value defined to be a "default value" that is mutually understood by the NS-provider and the NS-user as applying in the absence of particular values.

C.3.4 Throughput QOS parameters

The requested throughput, minimum acceptable throughput, burst size and agreed throughput of the Link Layer Core Parameters (LLCP) information element are derived from and used to derive the throughput QOS sub-parameters of the N-CONNECT primitives. The LLCP information element specifies the QOS at the core sublayer of the data link layer (see Annex A/Q.922). The methods for derivation of the values of these octet groups from the throughput QOS parameters of the N-CONNECT primitives, and for the derivation of the throughput QOS parameters of the N-CONNECT primitives from the values of these octet groups is a local matter. This derivation should take into account the operation of the sub-network dependent convergence protocol and data link control protocol. Separate values of the QOS sub-parameters may apply in each direction of transfer. The specific mappings of the Q.933 messages and octet groups in the LLCP information element to/from both sets of throughput sub-parameters is given in Table C.2.

TABLE C.2/Q.933

Mapping of throughput QOS sub-parameters to Q.933 messages and the LLCP information element

OSI-CONS		Rec. Q.933	
Sub-parameter	Primitive	LLCP Octet Group	Message
Target	N-CONNECTrequest	Throughput (request) committed Burst Size (requested)	SETUP (U → N)
Lowest quality acceptable	N-CONNECTrequest	Minimum Acceptable Throughput	SETUP (U → N)
Available	N-CONNECTindication	Throughput (available) committed Burst Size (available)	SETUP (N → U)
Lowest quality acceptable	N-CONNECTindication	Minimum Acceptable Throughput	SETUP (N → U)
Selected	N-CONNECTresponse	Throughput (agreed) committed Burst Size (agreed)	CONNECT (U → N)
Selected	N-CONNECTconfirm	Throughput (agreed) committed Burst Size (agreed)	CONNECT (N → U)

C.3.4.1 Processing of an N-CONNECT request primitive

When an NL entity receives an N-CONNECT request primitive, it checks the value of the requested throughput QOS. If the target values of the sub-parameters in either direction are unspecified, then the NL entity will use the default values.

If both of the values of the sub-parameters are specified, or if one value is specified, then the NL entity checks for the "lowest quality acceptable" value. If it cannot support this value, then it returns an N-DISCONNECT indication primitive to the calling NS user, and no Q.933 message is sent. The originator parameter of the N-DISCONNECT indication primitive is "NS-Provider", and the reason parameter is either "connection rejection – QOS not available/transient condition" (if the calling NL entity is temporarily unable to support the minimum acceptable QOS) or "connection rejection – QOS not available/permanent condition" (if the calling NL entity can never support the minimum acceptable QOS). Otherwise, the NL entity derives and encodes the appropriate values in the link layer core parameter information element, which is transmitted in a SETUP message across the ISDN user-network interface.

C.3.4.2 Processing a SETUP message

When an NL entity receives a SETUP message, it follows the procedures defined in 5.2.3.3. If the NL entity is unable to provide at least the lowest acceptable quality of service, the call is rejected by sending a RELEASE COMPLETE message. The cause location field of the Cause information element shall be encoded as "user", the cause value shall be encoded as # 49, "quality of service unavailable", and the diagnostic field shall be encoded as either "transient" (if the called NL entity is temporarily unable to support the minimum acceptable QOS) or "permanent" (if the called NL entity can never support the minimum acceptable QOS).

Otherwise, the NL entity derives, for both directions of transfer, the "available" and the "lowest quality acceptable" values of QOS and indicates them to the NS-user in the throughput QOS parameters of the N-CONNECT indication primitive.

C.3.4.3 Processing an N-CONNECT response primitive

When an NL entity receives an N-CONNECT response primitive, it encodes the "selected" values for each direction of transfer, as derived from throughput QOS parameters, in the agreed throughput field of the link layer core parameters information element of the CONNECT message.

C.3.4.4 Processing a CONNECT message

The CONNECT message received by the calling NL entity contains the agreed throughput fields in the Link layer core parameters information element. The fields are used to derive the "selected" throughput QOS parameters of the N-CONNECT confirm primitive and signalled to the calling NS-user.

C.3.5 Transit delay QOS parameter

The cumulative, requested and maximum end-to-end transit delay value octet groups of the end-to-end transit delay information element are derived from and used to determine the transit delay QOS parameters of the N-CONNECT primitives. In deriving the transit delay QOS parameters from this information element (and vice-versa), the NL entity shall take into account delays attributable to the operation of the NL entity, data link layer elements of procedure and core, and delays attributable to the effects of the rate of the ISDN access channel.

In order to support the transit delay QOS parameter in frame mode, three octet groups are used within the end-to-end transit delay information element as follows:

- the "target" value maps into the Requested End-to-End Transit Delay (RETD) octet group;
- the "lowest quality acceptable" value maps into the Maximum End-to-End Transit Delay (METD) octet group; and
- the "available" and "selected" values map into the Cumulative Transit Delay (CTD) octet group.

C.3.5.1 Processing an N-CONNECT request primitive

If an NL entity, upon receiving an N-CONNECT request primitive, cannot support the lowest quality acceptable transit delay, it rejects the request. In this case, it does not send any Q.933 message, but does return an N-DISCONNECT indication primitive to the calling NS-user. The originator parameter of the N-DISCONNECT indication primitive is "NS-Provider", and the reason parameter is either "connection rejection – QOS not available/transient condition" (if the calling NL entity is temporarily unable to support the minimum acceptable QOS) or "connection rejection – QOS not available/permanent condition" (if the calling NL entity can never support the minimum acceptable QOS).

If an NL entity, when receiving an N-CONNECT request primitive, can support the lowest quality acceptable transit delay (i.e. the maximum transit delay) when specified, or when the target transit delay is specified and the lowest quality acceptable transit delay is unspecified, then:

- the NL entity encodes the cumulative transit delay attributable to the calling end system in the cumulative transit delay value octet group of the end-to-end transit delay information element;
- the NL entity encodes the value of the target transit delay in the requested end-to-end transit delay value octet group of the end-to-end transit delay information element;
- if a lowest acceptable quality transit delay is specified, the NL entity encodes this value in the maximum end-to-end transit delay value octet group of the end-to-end transit delay information element; and
- the end-to-end transit delay information element is sent in the SETUP message.

Upon receiving an N-CONNECT request with both the target transit delay and the lowest acceptable quality transit delay values unspecified:

- the NL entity encodes the cumulative transit delay attributable to the calling end system in the cumulative transit delay value octet group of the end-to-end transit delay information element;
- the NL entity does not include the requested end-to-end transit delay value octet group and the lowest acceptable quality transit delay value octet group in the end-to-end transit delay information element; and
- the end-to-end transit delay information element is sent in the SETUP message.

C.3.5.2 Processing a SETUP message

When an NL entity receives a SETUP message, it follows the procedure of 5.2.3.3. In addition, it computes the total NC-transit delay by adding the cumulative transit delay value contained in the end-to-end transit delay information element to the cumulative transit delay attributable to the called end system. If the maximum end-to-end transit delay value octet group of the end-to-end transit delay information element is present, the NL entity compares its value to the total NC-transit delay calculated above. If the total NC-transit delay is greater than the maximum end-to-end transit delay, the NL entity clears the call by sending an appropriate clearing message (i.e. either RELEASE or RELEASE COMPLETE). The cause location field of the cause information element shall be encoded as “user”, the cause value shall be encoded as # 49, “quality of service unavailable”, and the diagnostic field shall be encoded as either “permanent” (if the called NL entity can never support the minimum acceptable QOS) or “transient” (if the called NL entity is temporarily unable to support the minimum acceptable QOS).

If the total NC transit delay is less than or equal to the maximum transit delay, or the maximum end-to-end transit delay value octet group of the end-to-end transit delay information element is not present, the NL entity indicates the total NC-transit delay as the available transit delay sub-parameter of the transit delay QOS parameter in the N-CONNECT indication primitive signalled to the called NS-user.

C.3.5.3 Processing an N-CONNECT response primitive

When an NL entity receives an N-CONNECT response primitive it includes the value of the total NC-transit delay calculated above in the CTD octet group of the end-to-end transit delay information element in the CONNECT message. The end-to-end transit delay information element in the CONNECT message contains only the CTD octet group.

C.3.5.4 Processing a CONNECT message

When an NL entity receives a CONNECT message, it maps CTD octet group of the end-to-end transit delay information element to the selected transit delay sub-parameter of the transit delay QOS parameter of the N-CONNECT confirm primitive signalled to the calling NS-user.

C.3.6 Priority QOS Parameters

NC Priority specifies relative importance of an NC with respect to gaining an NC; keeping an NC or data on the NC.

The set of values that can be specified for each Priority sub-parameter ranges from 0 (lowest priority) to 14 (highest priority). An NL entity supports all of these values. The value "unspecified" is also allowed (encoded as 15). The NC Priority parameters to gain an NC and to keep an NC together define the order in which NCs are to be broken to recover resources if necessary. The NS provider is required to accept new requests for NCs with high priority to gain an NC, if it can, even if NCs with a lower priority to keep an NC have to be released to do so.

The priority of data on the NC parameter defines the order in which NCs are to have their QOS degraded. An NC with a high priority of data on an NC is to have its request serviced within the required QOS first and remaining resources are then used to attempt to satisfy requests on lower priority NCs.

NOTE – The use or abuse of the NC Priority QOS-parameters can be controlled by one or more of the following:

– user discipline within a closed group of NS users;

– differential tariffs;

– management facilities within the Network Layer such that requests for NC Priority are policed and regulated.

C.3.6.1 Processing of an N-CONNECT request primitive

An NL entity that supports a choice of priority levels shall proceed as specified in the following subclause. An NL entity that does not support a choice of levels shall proceed as specified in the next subclause.

C.3.6.2 Processing of an N-CONNECT request primitive with choice of priority levels supported

If an NL entity, when receiving an N-CONNECT request primitive, cannot support the lowest quality acceptable priority for any of the three Priority QOS parameters (priority to gain an NC, priority to retain an NC and priority of data on an NC) when specified, then it rejects the request. In this case, the NL entity signals an N-DISCONNECT indication primitive to the calling NS user. The originator parameter is "NS Provider". The reason parameter is "Connection Rejection" – QOS Not Available/Transient Condition," or "Connection Rejection – QOS Not Available/Permanent Condition" if the NL entity could never support the lowest quality acceptable priority for one or more of the Priority QOS parameters.

If an NL entity, when receiving an N-CONNECT request primitive, can support the lowest acceptable priority for all the three Priority QOS parameters (priority to gain an NC, priority to retain an NC and priority of data on the NC) or any of the lowest quality acceptable QOS parameters is unspecified, then the NL entity encodes the Priority information element as follows:

a) if the lowest quality acceptable priority of a Priority parameter is specified, its value is encoded in the sub-field of the Priority information element designated to contain this sub-parameter; otherwise, this sub-field of this information element is encoded as 15 (unspecified); and

b) if the target of a Priority parameter is specified, its value is encoded in the sub-field of the Priority information element designated to contain this sub-parameter; otherwise, this sub-field of the information element is encoded as 15 (unspecified).

If either the target or the lowest quality acceptable priority is specified for any of the Priority QOS parameters, then the resulting Priority information element is transmitted across the interface in a SETUP message. Any sub-field of the Priority information element that contains the "unspecified" value (i.e. 15) may be omitted if, and only if, it is not followed by a sub-field containing a value other than "unspecified". If both the target and lowest quality acceptable priority are unspecified for all Priority QOS parameters, then no Priority information element is transmitted.

C.3.6.3 Processing of an N-CONNECT request primitive with choice of priority levels not supported

When an NL entity receives an N-CONNECT request primitive, it shall encode the lowest quality acceptable and target priority level for each Priority QOS parameter in the Priority information element for transmission across the interface in a SETUP message, unless both values of all parameters are unspecified, in which case it shall not transmit a Priority information element.

C.3.6.4 Processing of an incoming SETUP message by an end-system

An NL entity that supports a choice of priority levels shall proceed as specified in the following subclause. An NL entity that does not support a choice of levels shall proceed as specified in the next subclause.

C.3.6.4.1 Processing of a SETUP message with choice of priority levels supported

When receiving a SETUP message, an NL entity determines the available and lowest acceptable sub-parameters to be used in the N-CONNECT indication primitive for each Priority QOS parameter as follows:

a) if the message contains no Priority information element, then both sub-parameters for each Priority QOS parameter are unspecified;

b) if the sub-field of the Priority information element designated to contain the available sub-parameter for a Priority QOS parameter is present, then the value of this sub-parameter is as given in the sub-field; otherwise, the value is unspecified;

c) if the sub-field of the Priority information element designated to contain the lowest quality acceptable sub-parameter for a Priority QOS parameter is present, then the value of this sub-parameter is as given in the sub-field; otherwise, the value is unspecified.

If, for any of the three Priority QOS parameters (priority to gain an NC, priority to retain an NC and priority of data on the NC), the NL entity cannot support the lowest quality acceptable priority, then the NL entity clears the call (i.e. transmits a DISCONNECT message). The cause is "Normal call clearing". Otherwise, the NL entity indicates, for each Priority QOS parameter, the available and lowest quality acceptable priority values in the Priority QOS parameters of the N-CONNECT indication primitive signalled to the called NS user.

C.3.6.4.2 Processing of a SETUP message with choice of priority levels not supported

When an NL entity receives a SETUP message, the values of the available and lowest quality acceptable priority-level sub-parameters for use in the N-CONNECT indication primitive for each Priority QOS parameter shall be the values specified by the Priority information element in the message unless there is no Priority information element, in which case the values of both sub-parameters shall be "unspecified".

C.3.6.5 Processing of N-DISCONNECT Request, N-CONNECT Response primitives

If the called NS user does not agree to the Priority QOS parameter presented in the N-CONNECT indication primitive, then it signals an N-DISCONNECT request primitive to reject the NC. Consequently, the NL entity transmits a RELEASE COMPLETE message to reject the call. Otherwise, the NS user signals an N-CONNECT response primitive to the NL entity.

When an NL entity receives an N-CONNECT response primitive, it encodes the selected priority value, if specified, as given for each priority QOS parameter, in the X.213 priority information element returned in the CONNECT message. Any sub-field of the X.213 priority information element that contains the "unspecified" value (i.e. 15) may be omitted if, and only if, it is not followed by a sub-field containing the value other than "unspecified". If the selected priority value is unspecified for all Priority QOS parameters, then no X.213 priority information element is returned in the CONNECT message.

C.3.6.6 Processing of received CONNECT message in an end-system

When an NL entity receives a CONNECT message, it indicates the selected priority value, as given in the X.213 priority information element (if present), for each priority QOS parameter of the N-CONNECT confirm primitive signalled to the NS user. The absence of a sub-field in the X.213 priority information element corresponds to the value "unspecified". If the X.213 priority information element is not present in the CONNECT message, then the selected value of each priority QOS parameter is "unspecified".

C.3.7 NS-user data

When an NL entity receives an N-CONNECT request primitive it shall map the NS-user data parameter (if present) to the User-user information element in the SETUP message. The protocol discriminator field shall be encoded as "OSI high layer protocols".

When an NL entity receives a SETUP message, it shall map the User-user information element (if present) to the NS-user data parameter of the N-CONNECT indication primitive signalled to the called NS-user. Checking of the protocol discriminator field of the User-user information element is implementation dependent.

When an NL entity receives an N-CONNECT response primitive it shall map the NS-user data parameter (if present) to the User-user information element in the CONNECT message. The protocol discriminator field shall be encoded as "OSI high layer protocols".

When an NL entity receives a CONNECT message, it shall map the User-user information element (if present) to the NS-user data parameter of the N-CONNECT confirm primitive signalled to the calling NS-user. Checking of the protocol discriminator field of the User-user information element is implementation dependent.

C.3.8 Receipt confirmation selection and expedited data selection

C.3.8.1 Receipt confirmation selection

If the N-CONNECT request primitive indicates "use of receipt confirmation" in the receipt confirmation selection parameter, and if the NL entity can support receipt confirmation in the data transfer phase, then the NL entity shall encode "request indicated" in the receipt confirmation selection parameter of the Packet Layer Binary Parameter (PLBP) information element in the SETUP message. However, if "no use of receipt confirmation" is indicated in the N-CONNECT request, or if the NL entity cannot support it, then the NL entity shall encode "no request" in the PLBP information element of the SETUP message.

When an NL entity at the called end system receives a SETUP message with the PLBP information element requesting the use of receipt confirmation, and if the NL entity can support receipt confirmation, then the NL entity shall indicate "use of receipt confirmation" in the N-CONNECT indication primitive signalled to the NS user. However, if the NL entity cannot support the use of receipt confirmation, or if the PLBP information element indicates "no request", then the NL entity shall indicate "no use of receipt confirmation" in the N-CONNECT indication primitive signalled to the NS user.

When the NL entity receives an accepted N-CONNECT response primitive indicating "use of receipt confirmation", it shall encode "request accepted" in the bit for the receipt confirmation selection within the PLBP information element conveyed in the CONNECT message to indicate that receipt confirmation can be used during the life of the call. If the receipt confirmation parameter indicates "no use of receipt confirmation" in the N-CONNECT response primitive, then the NL entity shall encode "request denied" in the PLBP information element of the CONNECT message.

When the calling end system receives a CONNECT message with the PLBP information element indicating "request accepted" for receipt confirmation, the NL entity shall indicate "use of receipt confirmation" in the N-CONNECT confirm primitive sent to the NS user. However if the CONNECT message indicates "request denied", the NL entity shall indicate "no use of receipt confirmation" to the calling NS user. The call is completed regardless of the denial or acceptance of the use of receipt confirmation.

C.3.8.2 Expedited data selection

If the N-CONNECT request primitive indicates "use of expedited data" in the expedited data selection parameter, and if the NL entity can support expedited data in the data transfer phase then the NL entity shall encode "request indicated" in the expedited data selection bit of the Packet Layer Binary Parameter (PLBP) information element in the SETUP message. However, if "no use of expedited data" is indicated in the N-CONNECT request, or if the NL entity cannot support it, then the NL entity shall encode "no request" in the PLBP information element of the SETUP message.

When an NL entity at the called end system receives a SETUP message with the PLBP information element requesting the use of expedited data, and if the NL entity can support expedited data, then the NL entity shall indicate "use of expedited data" in the N-CONNECT indication primitive signalled to the NS user. However, if the NL entity cannot support the use of expedited data, or if the PLBP information element indicates "no request", then the NL entity shall indicate "no use of expedited data" in the N-CONNECT indication primitive signalled to the NS user.

When the NL entity receives an N-CONNECT response primitive indicating “use of expedited data”, it shall encode “request accepted” in the bit for the expedited data selection within the PLBP information element conveyed in the CONNECT message to indicate that expedited data can be used during the life of the call. If the expedited data parameter indicates “no use of expedited data” in the N-CONNECT response primitive, then the NL entity shall encode “request denied” in the PLBP information element of the CONNECT message.

When the calling end system receives a CONNECT message with the PLBP information element indicating “request accepted” for expedited data, the NL entity shall indicate “use of expedited data” in the N-CONNECT confirm primitive sent to the NS user. However, if the CONNECT message indicates “request denied”, the NL entity shall indicate “no use of expedited data” to the calling NS user. The call is completed regardless of the denial or acceptance of the use of expedited data.

C.4 Network connection release phase

Table C.3 shows the relationship between the primitives and parameters used during the network connection release phase and the messages and information elements associated with the call clearing procedures.

TABLE C.3/Q.933

Mapping of OSI-CONS to Q.933 for connection release phase

OSI-CONS	Rec. Q.933
Primitives:	Messages:
N-DISCONNECTrequest	DISCONNECT (U → N) RELEASE (U → N) RELEASE COMPLETE (U → N)
N-DISCONNECTindication	DISCONNECT (N → U) RELEASE (N → U) RELEASE COMPLETE (N → U) RESTART (N → U) (Note 1)
Parameters:	Information elements:
Responding address	Connected party number (Note 2) Connected party sub-address (Note 2)
Originator Reason NS-User-Data	Cause Cause User-user
NOTES 1 Receipt of a RESTART message shall be mapped to an N-DISCONNECTindication primitive for every active NC associated with the ISDN channel(s) or interface(s) being restarted. The Cause information element in the RESTART message is treated in the same manner as the Cause information element in the first clearing message of a normal call clearing procedure. 2 Depending on a variety of factors, an NSAP address might be totally encoded in a Connected party number information element, totally encoded in a Connected party sub-address information element or encoded partially in a Connected party Number information element and partially in a Connected party sub-address information element. See Recommendation I.334.	

C.4.1 Primitive/message mapping

When an NL entity receives an N-DISCONNECT request primitive from an NS-user it sends an appropriate clearing message (either DISCONNECT, RELEASE or RELEASE COMPLETE, depending on the state of the frame mode call – see 5.4.3). However, if the NL entity has previously initiated call clearing, or clearing has been initiated by the network, clearing is completed according to the procedures of 5.4.3.

If an NL entity detects an error in the operation of the Q.933 protocol for which the proper action is to clear the call (e.g. see 5.7/Q.931 and 5.8/Q.931), the appropriate clearing message is sent. If the call is associated with an NC, an N-DISCONNECT indication is signalled to the NS-user. Similarly, in frame mode case A, if the underlying circuit mode bearer connection is cleared, an N-DISCONNECT indication is signalled to all NS-users supported by that bearer connection.

When an NL entity receives the first clearing message of a normal or abnormal clearing sequence (either DISCONNECT, RELEASE, or RELEASE COMPLETE), it signals an N-DISCONNECT indication primitive to the NS-user, and completes the clearing procedure according to 5.4.4. If, however, the NS-user had previously signalled an N-DISCONNECT request, or the NL entity had previously indicated an N-DISCONNECT indication (i.e. in the case of a clear collision), no additional primitive shall be issued.

NOTE – If the received clearing message is in response to a SETUP message, the NL entity may retry the call if the NC-establishment delay QOS sub-parameter of the N-CONNECT request primitive has not been exceeded, rather than immediately signalling an N-DISCONNECT indication to the NS-user. The NL entity may, as a local matter, use the content of the Cause information element to determine whether or not to retry. The interval between retries is similarly a local matter.

When an NL entity receives a RESTART message, it signals an N-DISCONNECT indication primitive to the NS-user for each NC associated with the ISDN channel(s) or interface(s) being restarted, and completes the restart procedure according to 5.5.2. If, however, the NS-user had previously signalled an N-DISCONNECT request, or the NL entity had previously indicated an N-DISCONNECT indication, no additional primitive shall be issued.

If either NL entity wishes to disconnect an NC, it signals an N-DISCONNECT indication primitive to the NS-user and transmits an appropriate clearing message (DISCONNECT, RELEASE or RELEASE COMPLETE) to the network. If, however, the NL entity wishes to reject an NC instead of attempting a frame mode call (e.g. due to insufficient resources), then it signals an N-DISCONNECT indication primitive but does not send any clearing message.

C.4.2 Originator and reason

Table C.4 shows the mapping from the cause value, location and diagnostic fields of the Cause information element to originator and reason parameters of the N-DISCONNECT indication primitive.

Table C.5 shows the mapping from the originator and reason parameters of the N-DISCONNECT primitives to the cause value and diagnostic fields of the cause information element. The value of the location field of the cause information element is always “user”.

C.4.3 NS-user data

When an NL entity receives an N-DISCONNECT request primitive, it shall map the NS-user data parameter (if present) to the User-user information element in the first clearing message (i.e. either DISCONNECT, RELEASE or RELEASE COMPLETE). The protocol discriminator field shall be encoded as “OSI high layer protocols”.

When an NL entity receives the first clearing message associated with normal call clearing (i.e. DISCONNECT), it shall map the User-user information element (if present) to the NS-user data parameter of the N-DISCONNECT indication primitive signalled to the NS-user. Checking of the protocol discriminator field of the User-user information element is implementation dependent.

C.4.4 Responding address

Local operation determines the content of the Connected party number information element and/or connected party sub-address information element in the first clearing message (i.e. RELEASE or RELEASE COMPLETE) sent during call rejection. The relationship between NSAP addresses and Q.933 information elements is defined in Recommendation I.334.

TABLE C.4/Q.933

Mapping of cause information element contents to the originator and reason parameters of the N-Disconnect primitives

Location	Cause Value	Diagnostic	Originator	Reason
User	#16, Normal call clearing	NS-User, Normal	NS-User	Disconnection – normal condition
		NS-User, Abnormal	NS-User	Disconnection – abnormal condition
		NS-Provider, Permanent	NS-Provider	Disconnection – permanent condition
		NS-Provider, Transient	NS-Provider	Disconnection – transient condition
	#21, Call Rejected	NS-User, Permanent	NS-User	Connection rejection permanent condition
		NS-User, Transient	NS-User	Connection rejection – transient condition
		NS-Provider, Permanent	NS-Provider	Connection rejection, reason unspecified/permanent condition
		NS-Provider, Transient	NS-Provider	Connection rejection, reason unspecified/transient condition
	#88, Incompatible destination	User-user IE identifier	NS-User	Connection rejection – incompatible information in NS-user-data
	#49, Quality of Service unavailable	NS-User, Permanent	NS-User	Connection rejection – QOS not available – permanent condition
		NS-User, Transient	NS-User	Connection rejection – QOS not available – transient condition
		NS-Provider, Permanent	NS-Provider	Connection rejection – QOS not available – permanent condition
		NS-Provider, Transient	NS-Provider	Connection rejection – QOS not available – transient condition
Any	#1, Unallocated (unassigned) number #22 Number changed #28 Invalid number format	Any	NS-Provider	Connection rejection – NSAP address unknown
	#88, Incompatible destination	Called party number or Called party sub-address IE identifier	NS-Provider	Connection rejection – NSAP address unknown
		IE identifier other than those specified above	NS-Provider	Connection rejection – reason unspecified/permanent condition

TABLE C.4/Q.933 *(concluded)*

Mapping of cause information element contents to the originator and reason parameters of the N-Disconnect primitives

Location	Cause Value	Diagnostic	Originator	Reason
	#17, User busy #18, No user responding #34, No circuit/channel available #41 Temporary failure #42, Switching equipment congestion #44, Requested circuit/channel not available	Any	NS-Provider	Connection rejection – NSAP unreachable/transient condition
	#3, No route to destination	Transient or unknown	NS-Provider	Connection rejection – NSAP unreachable/transient condition
	#2, No route to specified transit network #27, Destination out-of-order #38, Network out-of-order #50, Requested facility not subscribed #57, Bearer capability not authorized #58, Bearer capability not presently available #63, Service or option not available, unspecified All causes in the "Service or option not implemented" class	Any	NS-Provider	Connection rejection – NSAP unreachable/permanent condition
	#3, No route to destination	Permanent	NS-Provider	Connection rejection – NSAP unreachable/permanent condition
	#26, Non-selected user clearing #41, Temporary failure	Any	NS-Provider	Disconnection – transient condition
	All causes in the following classes: service or option not implemented; invalid message; protocol error	Any	NS-Provider	Connection rejection – reason unspecified/permanent condition

TABLE C.5/Q.933

Mapping of originator and reason parameters of cause information element contents

Originator	Reason	Cause	Diagnostic
NS-User	Disconnection-normal condition	#16, Normal call clearing	NS-User, Normal
	Disconnection-abnormal condition	#16, Normal call clearing	NS-User, Normal
	Connection rejection – permanent condition	#21, Call rejected	Permanent
	Connection rejection	#21, Call rejected	Transient
	Connection rejection – QOS not available/transient condition	#49, Quality of Service unavailable	Transient
	Connection rejection – QOS not available/permanent condition	#49, Quality of Service unavailable	Permanent
	Connection rejection – incompatible information in NS-User-Data	#88, Incompatible destination	User-user IE identifier
NS-Provider	Disconnection – permanent condition	#16, Normal Call Clearing	NS-Provider, Permanent
	Disconnection – transient condition	#16, Normal Call Clearing	NS-Provider, Transient
	Connection rejection – NSAP unknown	#88, Incompatible Destination	Called party Sub-address or Called Party Number IE identifier
	Connection rejection - NSAP unreachable/transient condition	#3, No route to destination	NS-Provider, Transient
	Connection rejection - NSAP unreachable/permanent condition	#3, No route to destination	NS-Provider, Permanent
	Connection rejection, QOS not available/permanent condition	#49, Quality of Service unavailable	Permanent
	Connection rejection, QOS not available/transient condition	#49, Quality of Service unavailable	Transient
	Connection rejection, reason unspecified/permanent condition	#21, Call Rejected	Permanent
	Connection rejection, reason unspecified/transient condition	#21, Call Rejected	Transient
NOTE – The Cause Location field is always coded as “user” by the NL entity in an end system.			

Annex D

PICS proforma for Annex A[1)]

(This annex forms an integral part of this Recommendation)

D.1 Introduction

The supplier of a protocol implementation claiming to conform to Annex A/Q.933 shall complete the following Protocol Implementation Conformance Statement (PICS) proforma and accompany it by the information necessary to identify fully both the supplier and the implementation.

The PICS is a document specifying the capabilities and options which have been implemented, and any features which have been omitted, so that the implementation can be tested for conformance to relevant requirement only.

This PICS has several uses, the most important are the static conformance review and test case selection in order to identify which conformance tests are applicable to this product.

The PICS proforma is a document, in the form of a questionnaire, normally designed by the protocol specifier or conformance test suite specifier which, when completed for an implementation or system, becomes the PICS.

This PICS proforma applies to both network side and user side of implementations.

D.1.1 Abbreviations and special symbols

This annex uses the following terms defined in ISO/IEC 9646-1.

C Conditional.

IUT Implementation Under Test – an implementation of one or more OSI protocols in an adjacent user/provider relationship, being that part of an open system which is to be studied by testing.

M Mandatory.

N/A Not applicable.

No Not supported.

O Optional.

o.<n> Optional, but support required for either at least one or only one of the options in the group labelled with the same numeral <n>.

PICS A Protocol Implementation Conformance Statement (PICS) is a statement made by the supplier of an OSI implementation or system, stating which capabilities have been implemented, for a given OSI protocol.

PICS proforma A PICS proforma is a document, in the form of a questionnaire, designed by the protocol specifier or conformance test suite specifier, which when completed for an OSI implementation or system becomes the PICS.

SCR A Static Conformance Review (SCR) is a review of the extent to which the static conformance requirements are met by the IUT, accomplished by comparing the PICS with the static conformance requirements expressed in the relevant OSI International Standard(s) or ITU-T/CCITT Recommendation(s).

SCS A System Conformance Statement (SCS) is a document supplied by the client or product supplier that summarizes which OSI International Standards or ITU-T/CCITT Recommendations are implemented, and to which conformance is claimed.

---

1) Copyright Release for PICS proformas: Users of this annex may freely reproduce the PICS proforma in this annex, so that it can be used for its intended purpose and may further publish the completed PICS.

S/E Supplementary/Exceptional implementation information.

sp.<n> Status predicate – the status of this item is conditional based on the expression indicated by <n> in the predicate list.

SUT System Under Test – the open system in which the IUT resides.

X Prohibited use.

Yes Supported.

D.1.2 Instructions for completing the PICS proforma

D.1.2.1 Identification of the implementation

Identification of the Implementation Under Test (IUT) and the system in which it resides (the System Under Test or SUT) should be filled out to provide as much detail as possible regarding version numbers and configuration options.

The product supplier and client information should both be filled out if they are not one and the same.

A person who can answer queries regarding information supplied in the PICS should be named in the contact person section.

The PICS/SCS section should describe the relationship of this PICS to the SCS.

D.1.2.2 Global statement of conformance

If the answer to the statement in this section is "Yes", all subsequent sections shall be completed to facilitate selection of test cases for optional functions.

If the answer to the statement in this section is "No", all subsequent sections should be completed, and all non-supported mandatory capabilities shall be identified and explained in the comments section of each table.

D.1.2.3 Filling out the PICS proforma

The main part of the PICS proforma is a fixed-format questionnaire, divided into two sections. Answers to the questionnaire are to be provided in the right most column. Answering "Yes" to a particular question states that the implementation supports all the mandatory procedures for transmission and receipt of that function defined in the indicated references of Annex A/Q.933 (1993). Answering "No" to a particular question in this section states that the implementation does not support that function of the protocol.

A supplier may also provide additional information, categorized as either exceptional information or supplementary information. When present, each kind of additional information is to be provided as items labelled as E.<i> or S.<i> for cross reference purposes, where <i> is any unambiguous identification for the item. An exception item should contain the appropriate rationale. The supplementary information is not mandatory and the PICS is complete without such information. The presence of optional, supplementary or exceptional information should not affect test execution, and will in no way affect static conformance verification.

D.2 Identification of the implementation

Implementation Under Test (IUT) Identification

IUT Name:

IUT Version:

System Under Test (SUT) Identification

SUT Name:

Hardware Configuration:

Operating System:

Product Supplier

Name:

Address:

Telephone Number:

Facsimile Number:

Additional Information:

Client

Name:

Address:

Telephone Number:

Facsimile Number:

Additional Information:

PICS Contact Person

Name:

Telephone Number:

Facsimile Number:

Additional Information:

PICS/System Conformance Statement: Provide the relationship of the PICS with the System Conformance Statement for the system:

D.3 Identification of the protocol

This PICS proforma applies to the following Recommendation:

- ITU-T Recommendation Q.933 (1993), *Digital Subscriber Signalling System No. 1 (DSS 1) – Signalling specification for frame mode basic call control, Annex A.*

D.4 Global statement of conformance

The implementation described in this PICS meets all of the mandatory requirements of the referenced ITU-T Recommendation.

__ Yes

__ No

NOTE – Answering "No" indicates non-conformance to the specified protocol standard. Non-supported mandatory capabilities are to be identified in the following tables, with an explanation in the comments section of each table of why the implementation is non-conforming.

D.5 Procedures for frame relay PVC management

D.5.1 IUT configuration characteristics

Item #	Protocol feature	Status	Predicate	References	Support
C.1	Does the IUT support network side procedures?	o.1			Yes: __ No: __ S/E: __
C.2	Does the IUT support user side procedures?	o.1			Yes: __ No: __ S/E: __
o.<n> (s): o.1 Support of at least one of these options is required.					
Comments:					

D.5.2 Annex A procedures

Item #	Protocol feature	Status	Predicate	References	Support
AD.1	Frames carrying Layer 3 messages				
AD.1.1	Does the SUT transmit and receive the Annex A messages using Q.922 UI frames with the Poll bit set to 0?	M		Annex A – Introduction	Yes: __ No: __ S/E: __
AD.1.2	Does the SUT transmit and receive the frames on DLCI 0?	M		Annex A – Introduction	Yes: __ No: __ S/E: __
AD.1.3	Does the SUT set the FECN, BECN and DE frame bits to 0 when transmitting Annex A messages?	M		Annex A – Introduction	Yes: __ No: __ S/E: __
AD.1.4	Does the SUT set the C/R bit to 0 when transmitting UI frame?	M		Annex A – Introduction	Yes: __ No: __ S/E: __
AD.2	Procedures – Does the IUT support the following Annex A procedures?				
AD.2.1	Network side procedures				
AD.2.1.1	Periodic Polling – IUT responds to a STATUS ENQUIRY with a STATUS message	C	sp.1	A.4.1	Yes: __ No: __ S/E: __
AD.2.1.2	Link Integrity Verification – IUT modifies sequence numbers based on receipt of STATUS ENQUIRY and transmission of STATUS messages	C	sp.1	A.4.2, A.5.1	Yes: __ No: __ S/E: __
AD.2.1.3	IUT reports new PVCs to the user via the PVC Status New bit	C	sp.1	A.4.3	Yes: __ No: __ S/E: __
AD.2.1.4	IUT reports the availability of PVCs to the user via the PVC Status Active bit	C	sp.1	A.4.4	Yes: __ No: __ S/E: __
AD.2.1.5	Network equipment operation errors	C	sp.1	A.5.1	Yes: __ No: __ S/E: __
AD.2.1.6	IUT responds to a STATUS ENQUIRY/Report Type = link integrity verification only with a STATUS/Report Type = Full status	C	sp.2	A.4.1 4)	Yes: __ No: __ S/E: __

Item #	Protocol feature	Status	Predicate	References	Support
AD.2.1.7	IUT reports PVC information via STATUS/Report Type = single PVC asynchronous status	C	sp.2	A.1.1, A.5.1	Yes: __ No: __ S/E: __
AD.2.2	User side procedures				
AD.2.2.1	Periodic Polling – IUT initiates polling via the STATUS ENQUIRY message	C	sp.3	A.4.1	Yes: __ No: __ S/E: __
AD.2.2.2	Link Integrity Verification – IUT modifies sequence numbers based on receipt of STATUS and transmission of STATUS ENQUIRY message	C	sp.3	A.4.2, A.5.2	Yes: __ No: __ S/E: __
AD.2.2.3	IUT recognizes new PVCs via the PVC Status New bit	C	sp.3	A.4.3	Yes: __ No: __ S/E: __
AD.2.2.4	IUT recognizes deleted PVCs via absence of PVC status information element	C	sp.3	A.4.1	Yes: __ No: __ S/E: __
AD.2.2.5	IUT accepts PVC availability information via the PVC Status Active bit	C	sp.3	A.4.4	Yes: __ No: __ S/E: __
AD.2.2.6	User equipment operation errors	C	sp.3	A.5.2	Yes: __ No: __ S/E: __
AD.2.2.7	IUT accepts PVC availability information via STATUS/Report Type = single PVC asynchronous status	C	sp.4	A.5.1	Yes: __ No: __ S/E: __
AD.2.2.8	IUT accepts a STATUS/Report Type = full status in response to STATUS ENQUIRY/Report Type = link integrity verification only	C	sp.4	A.4.1 4)	Yes: __ No: __ S/E: __
AD.3	Supported messages and system parameters				
AD.3.1	Network side – Does the IUT				
AD.3.1.1	Accept STATUS ENQUIRY messages?	C	sp.1	A.1.1	Yes: __ No: __ S/E: __
AD.3.1.2	Transmit STATUS messages?	C	sp.1	A.1.2	Yes: __ No: __ S/E: __
AD.3.1.3	¿Implement N392?	C	sp.1	A.7; Table A.1	Yes: __ No: __ S/E: __
AD.3.1.4	¿Implement N393?	C	sp.1	A.7; Table A.1	Yes: __ No: __ S/E: __
AD.3.1.5	¿Implement T392?	C	sp.1	A.7; Table A.2	Yes: __ No: __ S/E: __
AD.3.2	User side – Does the IUT				
AD.3.2.1	Transmit STATUS ENQUIRY messages?	C	sp.3	A.1.1	Yes: __ No: __ S/E: __
AD.3.2.2	Accept STATUS messages?	C	sp.3	A.1.2	Yes: __ No: __ S/E: __

Item #	Protocol feature	Status	Predicate	References	Support
AD.3.2.3	Implement N391?	C	sp.3	A.7; Table A.1	Yes: __ No: __ S/E: __
AD.3.2.4	Implement N392?	C	sp.3	A.7; Table A.1	Yes: __ No: __ S/E: __
AD.3.2.5	Implement N393?	C	sp.3	A.7; Table A.1	Yes: __ No: __ S/E: __
AD.3.2.6	Implement T391?	C	sp.3	A.7; Table A.2	Yes: __ No: __ S/E: __

Predicates

sp.1 If C.1 = Yes then Status = Mandatory else Status = N/A

sp.2 If C.1 = Yes then Status = Optional else Status = N/A

sp.3 If C.2 = Yes then Status = Mandatory else Status = N/A

sp.4 If C.2 = Yes then Status = Optional else Status = N/A

Comments:

D.5.3 Predicate list

sp.1 If C.1 = Yes then Status = Mandatory else Status = N/A.

sp.2 If C.1 = Yes then Status = Optional else Status = N/A.

sp.3 If C.2 = Yes then Status = Mandatory else Status = N/A.

sp.4 If C.2 = Yes then Status = Optional else Status = N/A.

D.5.4 o.<n> list

o.1 Support of at least one of these options is required.

Annex E

Multiprotocol encapsulation over frame relay

(This annex forms an integral part of this Recommendation)

This annex describes encapsulation methods for carrying multiple protocols over a frame relay connection and network interconnect (e.g. LAN-to-LAN) traffic over a frame relay network. Support of multiprotocol encapsulation is optional; if supported, the requirements of this annex apply. For network interconnect, it covers aspects of both bridging and routing. Terminal equipment which support the encapsulation method must know which virtual connections will carry which encapsulation method. Encapsulation procedures shall be used only over permanent virtual connections that have been explicitly configured or switched virtual connections that are established with the low layer capability information element coded to indicate ISO TR 9577 encapsulation during call setup.

E.1 Introduction

The frame relay network provides virtual connections between devices attached to the frame relay network. Use of frame relay connections include:

- terminals that are directly connected (point-to-point); or
- interconnection of networks by bridges or routers. Interconnected devices form a frame relay group which may be either fully connected with a complete "mesh" of virtual circuits, or only partially connected.

Each virtual circuit is uniquely identified at each frame relay interface by a Data Link Connection Identifier (DLCI). DLCIs have strictly local significance at each frame relay interface.

It is desirable that multiple protocols can share the same frame relay connection to simplify configuration and load balance. The basic format of headers for data to be transferred on a frame relay network must be defined to allow the selection of the correct protocol stack to process the data at the remote end. The frame relay network need not understand these formats. This capability can be provided using Network Layer Protocol Identifiers (NLPID) as defined in ISO/IEC TR 9577.

The procedures in this annex are intended to apply to both switched and permanent virtual connections.

E.2 Frame format

All protocols shall have encapsulated their packets within a Q.922 frame. Additionally, frames shall contain information necessary to identify the protocol carried within the frame relay Protocol Data Unit (PDU), thus allowing the receiver to properly process the incoming packet. The frame format is shown in Figure E.1.

The first octet of frame relay user information field is the Q.922 control field. For unacknowledged information transfer, the UI (0x03) value of Recommendation Q.922 control field is used. For acknowledged HDLC elements of procedure (e.g. Recommendation Q.922), I and Supervisory frames are used. I frames are used to support layer 3 protocols which require an acknowledged data link layer.

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

E.2.1 Numbering convention

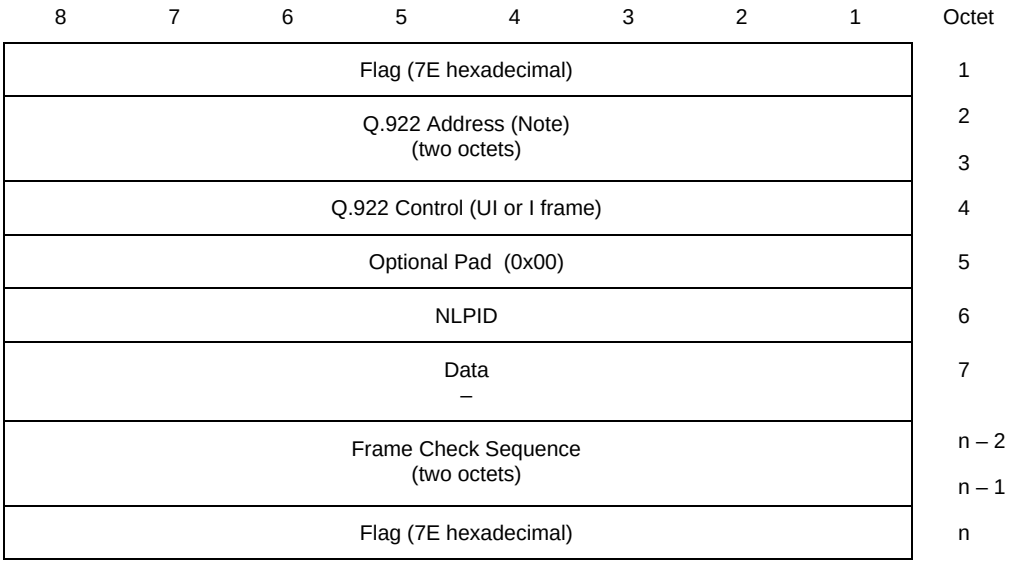
The basic convention used in this subclause is illustrated in Figure E.1. The bits are grouped into octets. The bits of an octet are shown horizontally and are numbered from 1 to 8. Multiple octets are shown vertically and are numbered from 1 to n.

E.2.2 Order of bit transmission

The octets are transmitted in ascending numerical order; inside an octet bit 1 is the first bit to be transmitted.

E.3 Multiprotocol encapsulation

The Network Layer Protocol ID (NLPID) field is administered by ISO and ITU-T. It contains values for many different protocols including IP, CLNP (ISO 8473), Recommendation Q.933, ISO 8208 and IEEE Sub-Network Access Protocol (SNAP). This field tells the receiver what encapsulation or what protocol follows. Values for this field are defined in ISO/IEC TR 9577. A NLPID value of 0x00 is defined within ISO/IEC TR 9577 as the Null Network Layer or Inactive Set. Since it cannot be distinguished from a pad field, and because it has no significance within the context of this encapsulation scheme, a NLPID value of 0x00 is invalid under the frame relay encapsulation.



NOTE – The default address length is two octets and contains a 10-bit DLCI. Optionally, some networks may also offer four-octet addresses, in which case the length is established by subscription.

FIGURE E.1/Q.933

Frame relay frame format

Figure E.2 summarizes a generic encapsulation technique over frame relay networks. It allows the identification of multiple alternatives to identify different protocols used either by:

- end systems; or
- bridges or routers (e.g. for interconnection of LANs); or
- a combination of the above;

over frame relay networks.

If a protocol can be encapsulated in more than one multiprotocol header format, the first format from the list below, which provides a code point for the protocol, shall be used.

1) Direct NLPID – Protocols for which a NLPID value is defined in TR 9577; e.g. IP, CLNP (ISO 8473) and ISO 8208.

2) SNAP encapsulation – Using SNAP NLPID followed by SNAP, e.g. LAN bridging and connectionless protocols which have a SNAP value.

3) NLPID followed by four octets indicating layer 2 and layer 3 identifications, i.e. connection-oriented protocols and other protocols which cannot be supported by the other two methods.

E.4 Directly connected frame relay terminal equipment

The frame relay connections between directly connected Terminal Equipment (TE) can be established either by subscription for PVCs or using call control procedures for SVCs. In case of SVCs, the data transfer protocol can be indicated during call establishment between user equipment using the low layer compatibility information element. It is possible to support multiple protocols over both PVCs and SVCs. See Figure E.3.

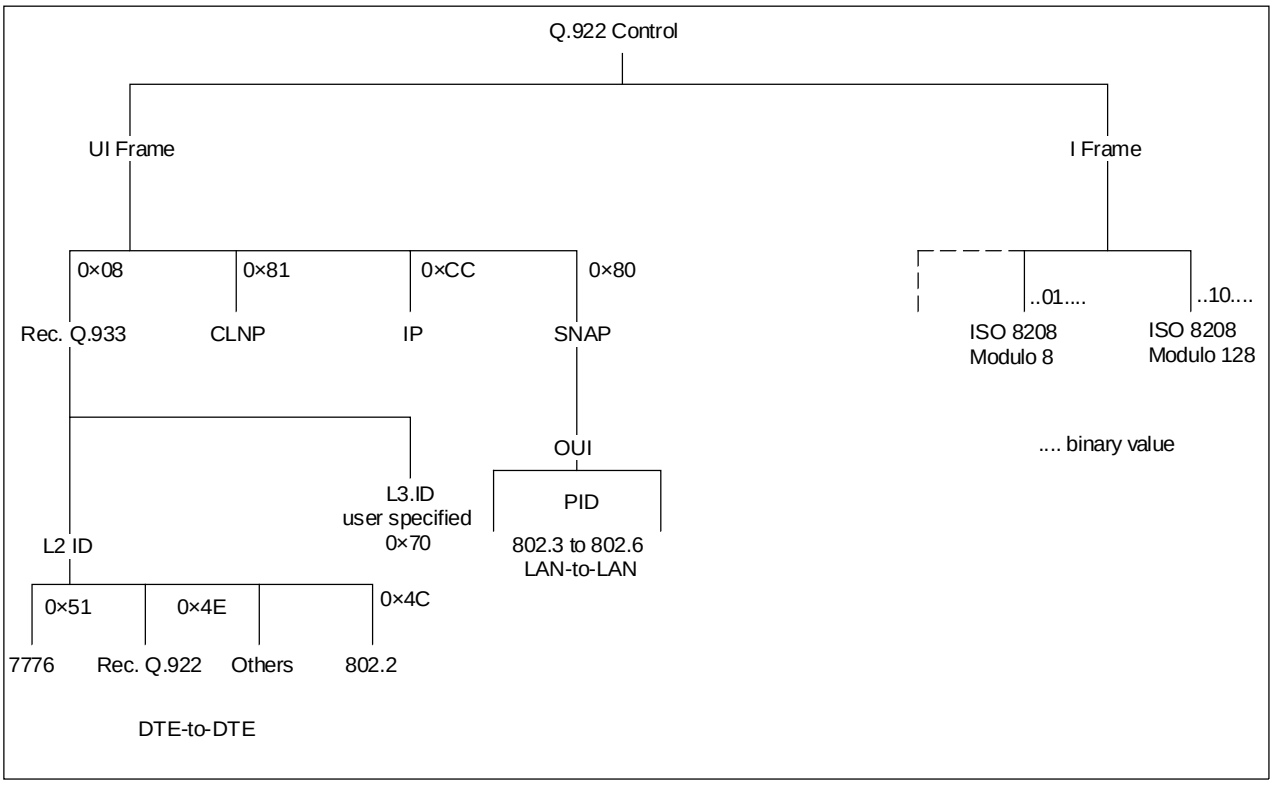


FIGURE E.2/Q.933

Multiprotocol encapsulation

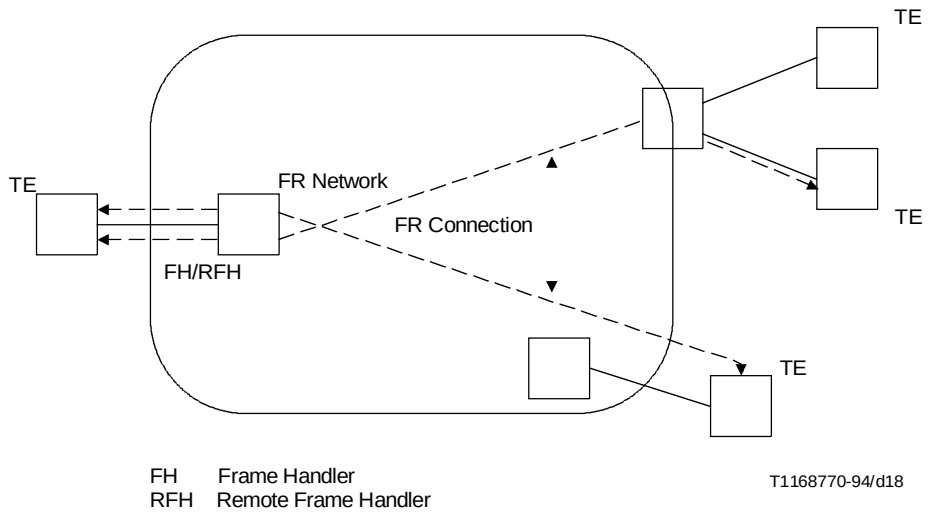


FIGURE E.3/Q.933

Directly connected frame relay terminal equipment

E.4.1 Encapsulations using UI frame (layer 2)

E.4.1.1 ISO CLNP (ISO 8473) over frame relay

ISO CLNP has a NLPID defined (0x81). Therefore, the NLPID field will indicate ISO CLNP and the unit data PDU immediately. In this example, the NLPID is used to identify the data packet as CLNP. It is also considered part of the CLNP unit data PDU and as such, it shall be retained. The frame would be as follows (see Figure E.4):

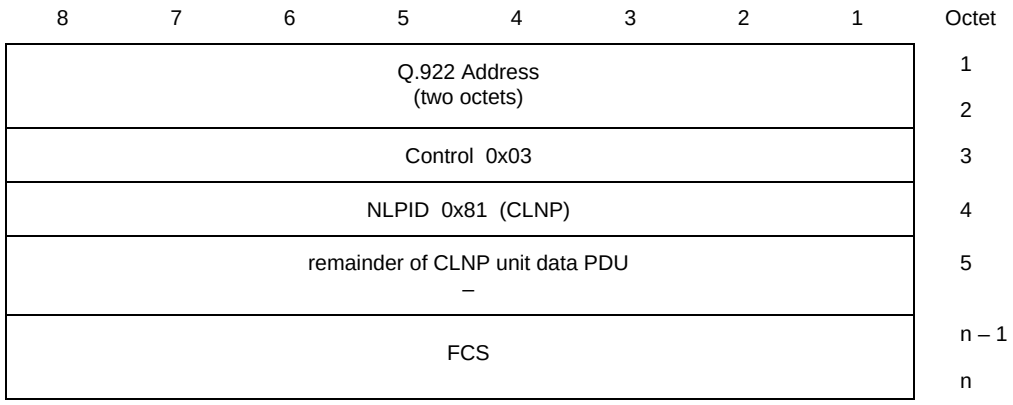


FIGURE E.4/Q.933

Encapsulation of CLNP (ISO 8473) unit data PDU

E.4.1.2 IP over frame relay

Internet Protocol (IP) has a NLPID defined (0xCC). The IP datagrams sent over a frame relay network will follow the multiprotocol encapsulation. The NLPID field will indicate IP and the IP datagram will follow immediately. The frame would be as follows (see Figure E.5):

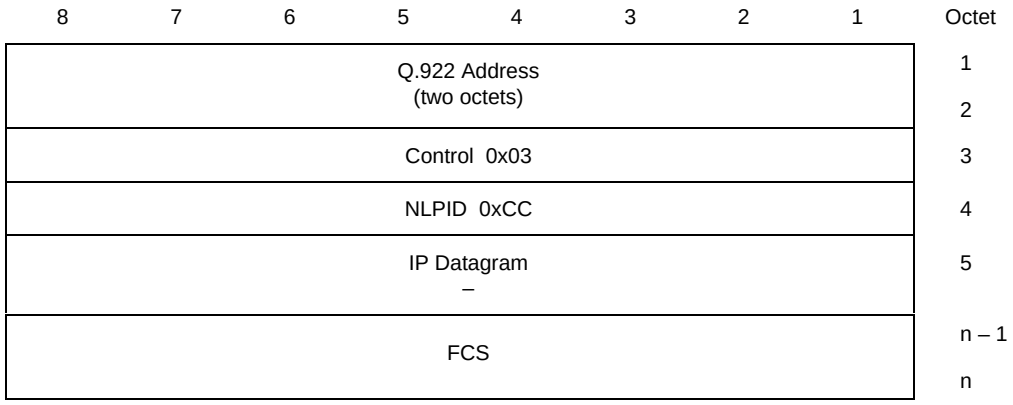


FIGURE E.5/Q.933

Encapsulation of an IP datagram

E.4.1.3 Other protocols

Some protocols do not have a specific NLPID assigned to them. When packets of such protocols are sent over a frame relay connection supporting multiprotocol encapsulation, they use NLPID 0x08 (which indicates Recommendation Q.933). The 4 bytes following NLPID include both layer 2 and layer 3 protocol identifications. The code points for most protocols are currently defined in Recommendation Q.933 Low layer compatibility information element (see 4.5.21, octet 6 and 7 codings). There is also an escape for defining non-standard protocols. See Figure E.6.

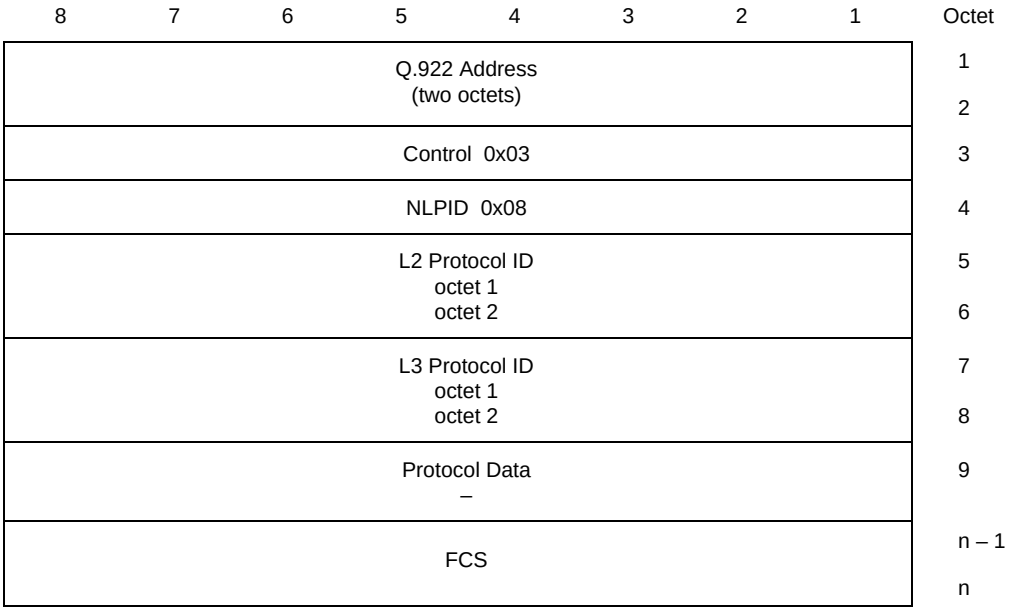


FIGURE E.6/Q.933

Format of other protocol frame using Q.933 NLPID

E.4.1.3.1 ISO 8802-2 with user specified layer 3

See Figure E.7.

E.4.2 Encapsulations using I frame (layer 2)

The Q.922 I frame is for supporting layer 3 protocols which require acknowledged data link layer (e.g. ISO 8208). The C/R bit (Q.922 address) will be used for command and response indications. Access to an X.25 packet network by a DTE when encapsulating a single protocol per frame relay connection is not covered by this annex.

E.4.2.1 ISO 8208 modulo 8

See Figure E.8.

E.4.2.2 ISO 8208 modulo 128

See Figure E.9.

8	7	6	5	4	3	2	1	Octet
Q.922 Address (two octets)								1 2
Control 0x03								3
NLPID 0x08								4
8802-2 0x4C 0x80 (Note 1)								5 6
User Spec. 0x70 (Note 2)								7 8
DSAP								9
SSAP								10
Control (Note 3)								11
remainder of PDU –								
FCS								n – 1 n

NOTES

1 Required for padding.

2 Indicates the code point for user specified layer 3 protocol.

3 Control field is two octets for I-format and S-format frames (see 8802-2).

FIGURE E.7/Q.933

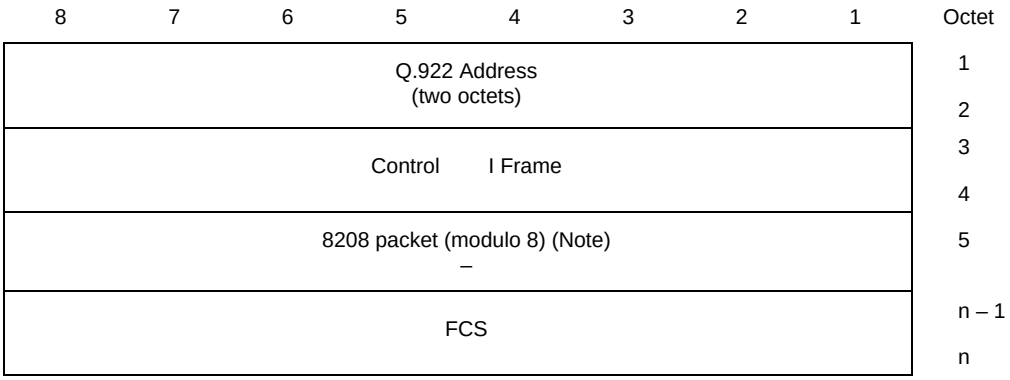
Format of frame with 802-2 (layer 2) and user specified (layer 3)

8	7	6	5	4	3	2	1	Octet
Q.922 Address (two octets)								1 2
Control I Frame								3 4
8208 packet (modulo 8) (Note) –								5
FCS								n – 1 n

NOTE – First octet of 8208 packet also identifies the NLPID which is "..01....".

FIGURE E.8/Q.933

Format of ISO 8208 frame modulo 8



NOTE – First octet of 8208 packet also identifies the NLPID which is "..10....".

FIGURE E.9/Q.933

Format of ISO 8208 frame modulo 128

E.5 Network interconnect

Network interconnect (e.g. LAN-to-LAN) is provided by bridge(s) or router(s). Two basic types of data packets are covered by multiprotocol encapsulation within the frame relay network, routed packets and bridged packets. These packets have distinct formats and therefore, must contain an indication so that the destination may correctly interpret the contents of the frame. This indication is embedded within the NLPID and SNAP header information. See Figure E.10.

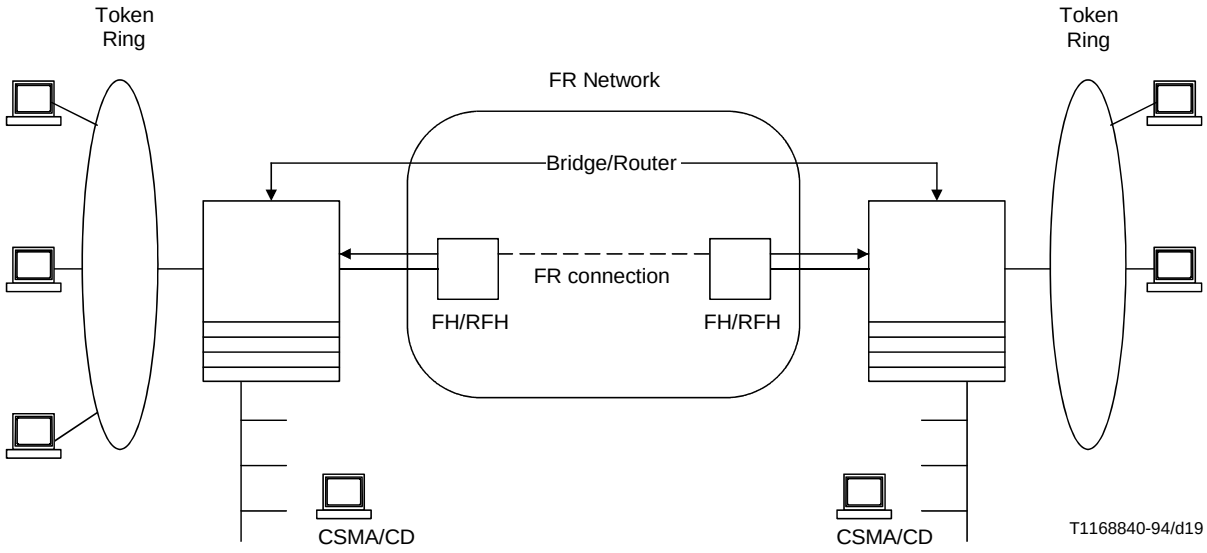


FIGURE E.10/Q.933

LAN-to-LAN interconnect

For those protocols that do not have an NLPID assigned, it is necessary to provide a mechanism to allow protocol identification. There is a NLPID value defined indicating the presence of a SNAP header.

A SNAP header is of the form:

Organizationally Unique	
Identifier	Protocol
Identifier	

All bridges or routes must be able to accept and properly interpret both the NLPID encapsulation and the SNAP header encapsulation for a routed packet.

The three-octet Organizationally Unique Identifier (OUI) identifies an organization which administers the meaning of the Protocol Identifier (PID) which follows. Together they identify a distinct protocol.

E.5.1 Routed packets

The first type of encapsulated traffic is routed packets. Some protocols will have an assigned NLPID, but because the NLPID numbering space is so limited many protocols do not have a specific NLPID assigned to them. When packets of such protocols are routed over frame relay networks they are sent using the NLPID 0x80 (which indicates a SNAP follows). See Figure E.11.

8	7	6	5	4	3	2	1	Octet
Q.922 Address (two octets)								1 2
Control 0x03								3
pad 0x00								4
NLPID 0x80								5
OUI OUI (continue) OUI (continue)								6 7 8
PID PID (continue)								9 10
Protocol Data –								11
FCS								n – 1 n

FIGURE E.11/Q.933

Format of routed frames

For those protocols which have been assigned a NLPID, 48 bits are saved using the format of Figure E.12.

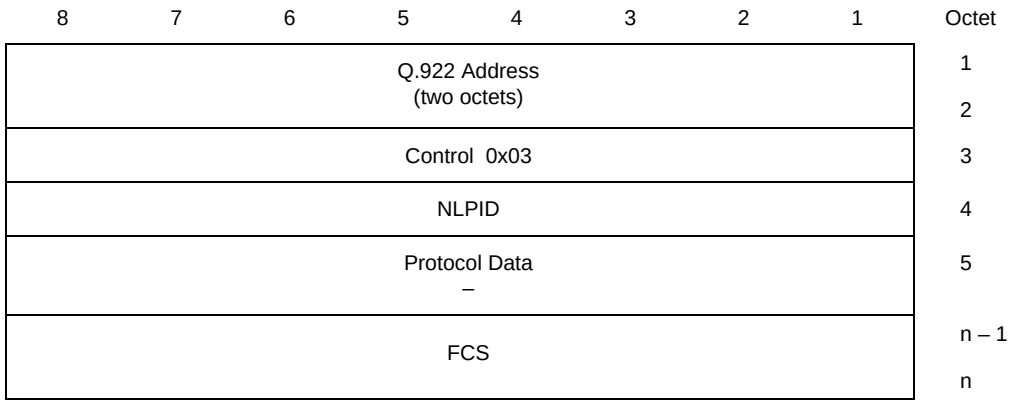


FIGURE E.12/Q.933

Format of routed NLPID protocol

In the case of ISO protocols, the NLPID is considered to be the first octet of the protocol data. The single octet serves both as the demultiplexing value and as part of the protocol data (see E.4.1.1). Other protocols, such as IP, have a NLPID defined (0xCC), that is not part of the protocol itself. The encapsulation of an Internet Protocol (IP) datagram is shown in Figure E.5.

E.5.2 Bridged packets

The second type of encapsulated traffic is bridged packets. These packets are encapsulated using the NLPID value of 0x80 indicating SNAP and the following SNAP header identifies the format of the bridged packet. The OUI value used for this encapsulation is the IEEE 802.1 organization code 0x00-80-C2. The following two octets (PID) specify the form of the MAC header, which immediately follows the SNAP header. Additionally, the PID indicates whether the original FCS is preserved within the bridged frame.

The IEEE 802.1 has reserved the following values to be used with multiprotocol encapsulation over frame relay. See Table E.1.

TABLE E.1/Q.933

PID values for OUI 0x00-80-C2

With preserved FCS	w/o preserved FCS	Media
0x00-01	0x00-07	802.3
0x00-02	0x00-08	802.4
0x00-03	0x00-09	802.5
0x00-04	0x00-0A	FDDI
	0x00-0B	802.6

Three additional PID values are reserved for use with OUI 0x00-80-C2:

0x00-0D identifies a packet fragment (see E.5.3).

0x00-0E identifies Bridge Protocol Data Units (BPDUs) as defined by IEEE 802.1(d) or 802.1(g).

0x00-0F identifies Source Routing BPDUs.

A packet bridged over frame relay will, therefore, have one of the following formats (see Figures E.13 to E.17):

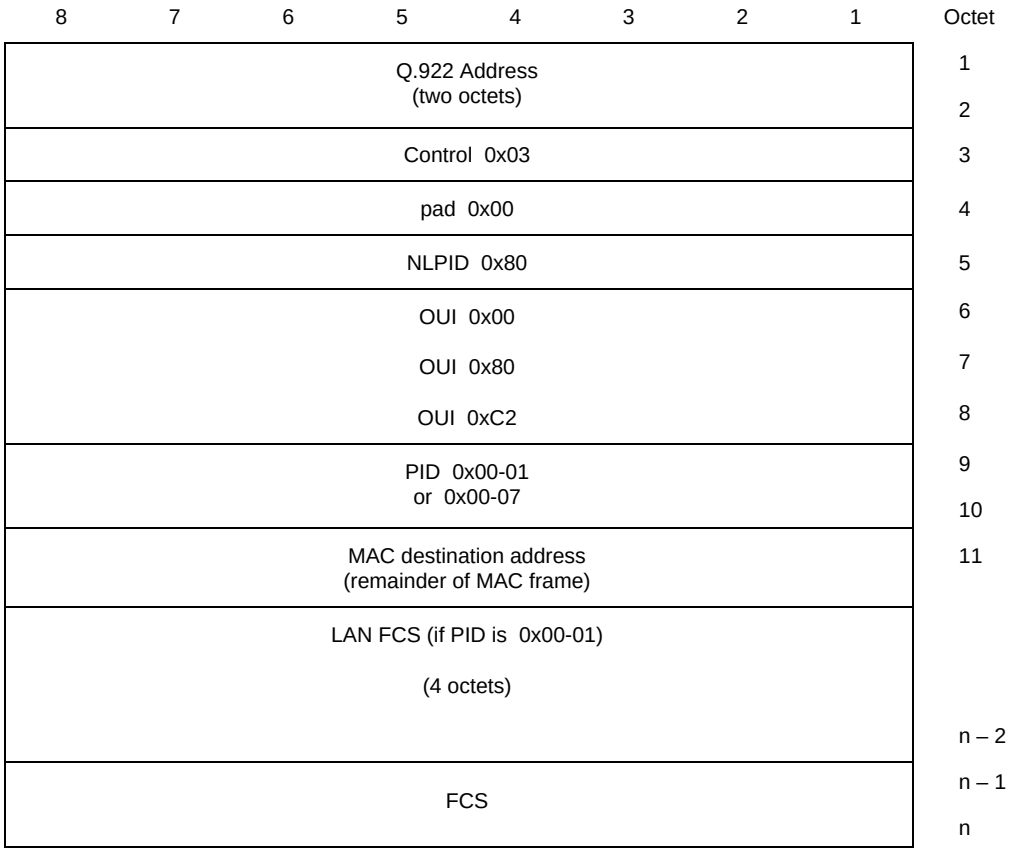


FIGURE E.13/Q.933

Format of bridged 802.3 frame

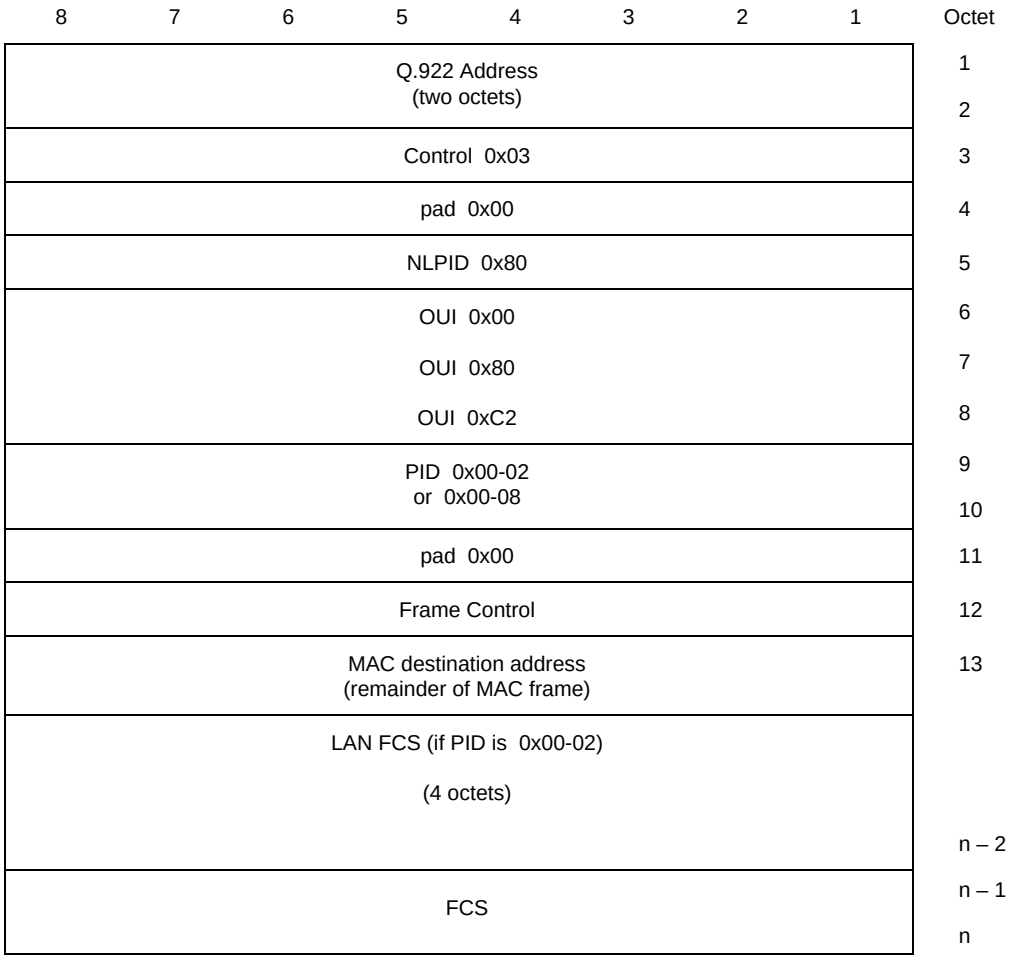


FIGURE E.14/Q.933

Format of bridged 802.4 frame

8	7	6	5	4	3	2	1	Octet
Q.922 Address (two octets)								1 2
Control 0x03								3
pad 0x00								4
NLPID 0x80								5
OUI 0x00								6
OUI 0x80								7
OUI 0xC2								8
PID 0x00-03 or 0x00-09								9 10
pad 0x00								11
Frame Control								12
MAC destination address (remainder of MAC frame)								13
LAN FCS (if PID is 0x00-03) (4 octets)								n – 2
FCS								n – 1 n

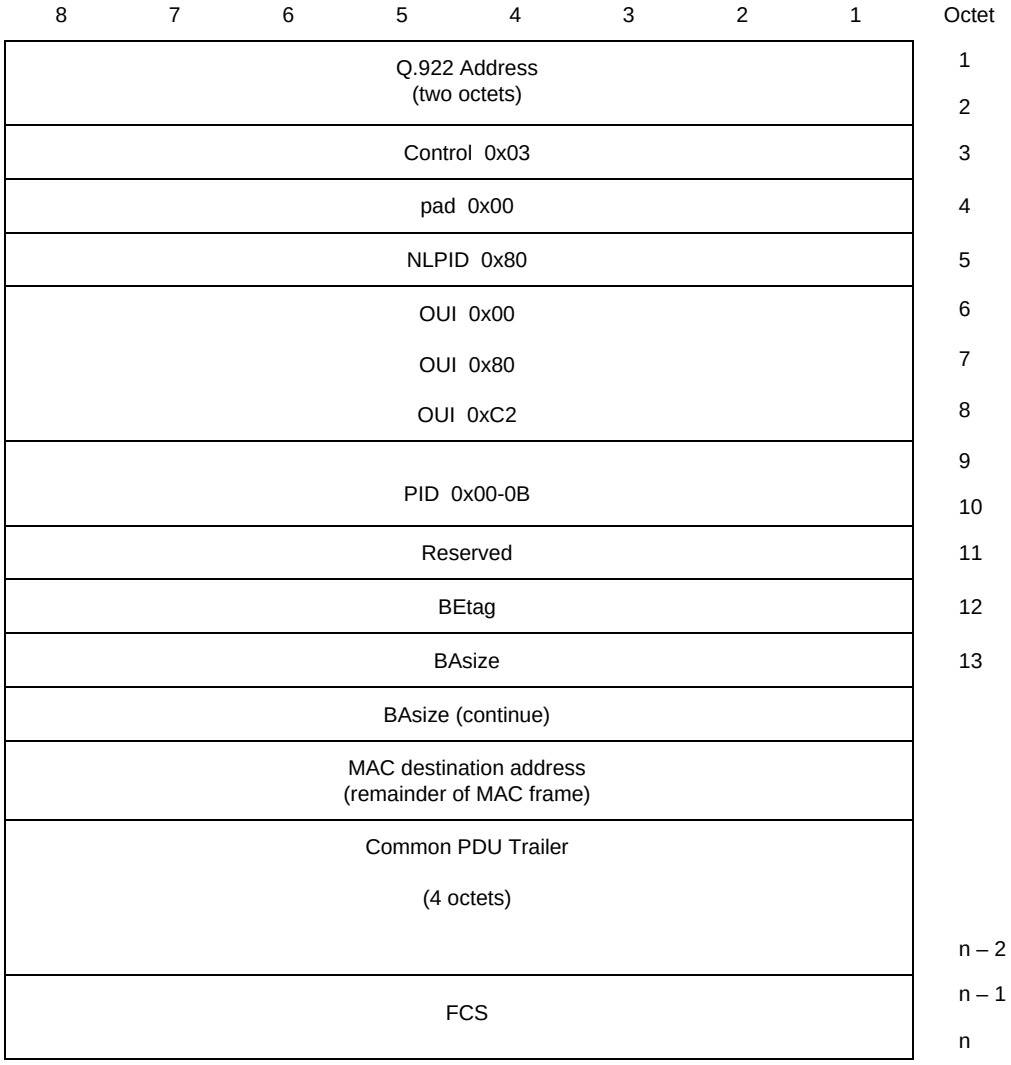
FIGURE E.15/Q.933

Format of bridged 802.5 frame

8	7	6	5	4	3	2	1	Octet
Q.922 Address (two octets)								1 2
Control 0x03								3
pad 0x00								4
NLPID 0x80								5
OUI 0x00								6
OUI 0x80								7
OUI 0xC2								8
PID 0x00-04 or 0x00-0A								9 10
pad 0x00								11
Frame Control								12
MAC destination address (remainder of MAC frame)								13
LAN FCS (if PID is 0x00-04) (4 octets)								n – 2
FCS								n – 1 n

FIGURE E.16/Q.933

Format of bridged FDDI frame



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

FIGURE E.17/Q.933

Format of bridged 802.6 frame

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

The common PDU header and trailer of the encapsulated frame should not be simply copied to the outgoing 802.6 subnetwork because the encapsulated BEtag value may conflict with the previous BEtag value transmitted by that bridge. See Figures E.18 and E.19.

8	7	6	5	4	3	2	1	Octet
Q.922 Address (two octets)								1 2
Control 0x03								3
pad 0x00								4
NLPID 0x80								5
OUI 0x00								6
OUI 0x80								7
OUI 0xC2								8
PID 0x00-0E								9 10
BPDU as defined by 802.1(d) or 802.1(g)								13
FCS								n – 1 n

FIGURE E.18/Q.933

Format of BPDU frame

8	7	6	5	4	3	2	1	Octet
Q.922 Address (two octets)								1 2
Control 0x03								3
pad 0x00								4
NLPID 0x80								5
OUI 0x00								6
OUI 0x80								7
OUI 0xC2								8
PID 0x00-0F								9 10
Source Routing BPDU								11
– FCS								n – 1 n

FIGURE E.19/Q.933

Format of source routing BPDU frame

E.5.3 Fragmentation issues

Fragmentation allows the exchange of packets that are greater than the maximum frame size supported by the underlying network. In the case of frame relay, the network may support a maximum frame size as small as 262 octets, although support of maximum frame size of at least 1600 octets (i.e. large enough to carry an unfragmented IEEE 802.3 frame) is strongly recommended. Because of this small maximum size, it is advantageous to support fragmentation and reassembly.

The scope of frame relay fragmentation procedure is limited to the boundary (or TEs) of the frame relay network.

The general format of fragmented packets is the same as any other encapsulated protocol. The most significant difference is that the fragmented packet will contain the encapsulation header. That is, a packet is first encapsulated (with the exception of the address and control fields) as defined above. Large packets are then broken up into frames appropriate for the given frame relay network and are encapsulated using the frame relay fragmentation format. In this way, a station receiving fragments may reassemble them and then put the reassembled packet through the same processing path as a packet that had not been fragmented.

Within frame relay fragments are encapsulated using the SNAP format with an OUI of 0x00-80-C2 and a PID of 0x00-0D. Individual fragments will, therefore, have the following format given in Figure E.20.

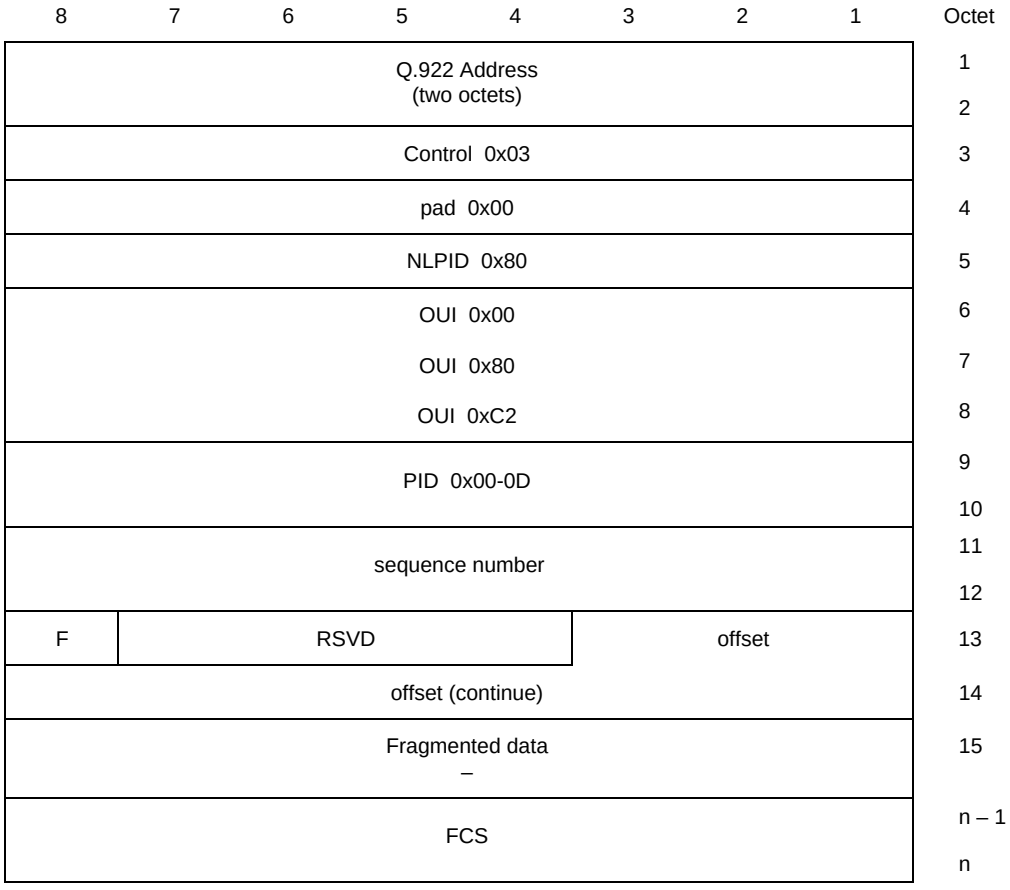


FIGURE E.20/Q.933

Format of individual fragment

The sequence field is a two octet identifier that is incremented every time a new complete message is fragmented. It allows detection of lost frames and is set to a random value at initialization.

The reserved field is 4 bits long and is not currently defined. It must be set to 0.

The final bit is a one bit field set to 1 on the last fragment and set to 0 for all other fragments.

The offset field is an 11 bit value representing the logical offset of this fragment in bytes divided by 32. The first fragment must have an offset of zero.

Fragments must be sent in order starting with a zero offset and ending with the final fragment. These fragments must not be interrupted with other packets or information intended for the same DLC. An end station must be able to reassemble up to 2K octets and is suggested to support up to 8K octet reassembly. If at any time during this packet reassembly process a fragment is corrupted or a fragment is missing, the entire packet is dropped. The upper layer protocol is responsible for any retransmission in this case.

This fragmentation algorithm is not intended to reliably handle all possible failure conditions. As with IP fragmentation, there is a small possibility of reassembly error and delivery of an erroneous packet. Inclusion of a higher layer checksum greatly reduces this risk.

Appendix I

Window size for a data link layer protocol

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

This appendix may be used to negotiate the window size parameter of the data link layer protocol. The following formula should be used to calculate the window size:

$$k = 2 + T_{td} \times R_u / (4 \times L_d)$$

where:

L_d data frame size in octets;

R_u throughput bits/sec;

T_{td} end-to-end transit delay in sec;

k window size (maximum number of outstanding I frames).

The window size should be negotiated as follows. The originating user should calculate k using the above formula substituting Maximum end-to-end transit delay and outgoing maximum frame size for T_{td} and L_d respectively. The SETUP message shall include the link layer protocol parameters, the link layer core parameters, and the end-to-end transit delay information elements. The destination user should calculate its own k using the above formula substituting cumulative end-to-end transit delay and its own outgoing maximum frame size for T_{td} and T_d respectively. The CONNECT message shall include the link layer core parameters and the end-to-end transit delay information element so that the originating user can adjust its k based on the information conveyed in these lEs. The originating user should calculate k using the above formula substituting cumulative end-to-end transit delay and Incoming maximum frame size for T_{td} and L_d respectively.

Appendix II

Additional procedures for multipoint Permanent Virtual Connections (PVCs)

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

This appendix describes procedures for use with Annex A in reporting the status of multipoint Permanent Virtual Connections, in relation with frame relay Multicast PVC capability.

The multipoint configurations for Permanent Virtual Connections are described in Recommendation I.233.1, Multicast service aspects of frame relay. Below is a brief description of these Multicast configurations, and reference can also be made to Recommendation X.6. It should be noted that multipoint connections may co-exist on an interface with point-to-point connections.

II.1 Terminology

For the proposes of this Recommendations, the following definitions apply.

II.1.1 **active group:** The subset of a Multicast Group which is currently operational.

II.1.2 **leaf**: A member of a one-way or two-way Multicast Group which receives Multicast frames.

II.1.3 **multicast group**: A set of members participating in a frame relay Multicast configuration.

II.1.4 **member**: A participant in a Multicast Group.

II.1.5 **multicast PVC**: Is identified by Mdlci, which is the DLCI assigned to designate a particular multipoint Permanent Virtual Connection at a particular frame relay access interface (DLCI values have only local significance).

II.1.6 **multicast server**: The logical entity which provides the Multicast service to all members.

II.1.7 **root**: The member of a one-way or two-way Multicast Group which transmits Multicast frames.

II.1.8 **station**: A frame relay DTE. That is any user side equipment (router, host, etc.) that uses the services of a frame relay network. In the context of this appendix, station does not refer to those devices that are a part of the frame relay network itself.

II.2 Description of Multicast PVC configurations

There are three types of Multicast configurations. All require a one to many mapping of source to destination, but each requires the service provider to interpret the meaning of multiple destinations differently. These configurations are described in the following subclauses.

II.2.1 One-way Multicast PVC configuration

The one-way Multicast configuration requires that the root has point-to-point frame relay connections established to all leaves in the Multicast Group. The root shall also maintain a separate one-way Multicast connection to the Multicast Server.

With this configuration, the root sends Multicast frames via the one-way Multicast connection identified by a one-way Multicast DLCI (Mdlci). The Multicast server accepts frames from the Mdlci and sends the frame to each leaf member of the active Multicast Group. Frames delivered in this manner arrive as though they were transmitted on the individual point-to-point connections established between the root and leaves. That is the DLCI (address) in the received frame reflects the source of the message and will not retain the Mdlci (Multicast address).

For example, Figure II.1 shows the root, Station A, with a single frame relay interface (Station A may have other interfaces which are not shown here). The Multicast Group may be viewed logically as the group of PVCs b, c and d. The one-way Multicast configuration server will accept a frame on Mdlci from Station A and transmit it to each destination designated by the active Multicast Group. As these frames traverse the network, they are treated no differently than other frames and, therefore, arrive at the destination stations as though they had been transmitted on each of the separate PVCs from Station A. Station B will receive the frame on its connection t, Station C on its connection u and Station D on its connection v.

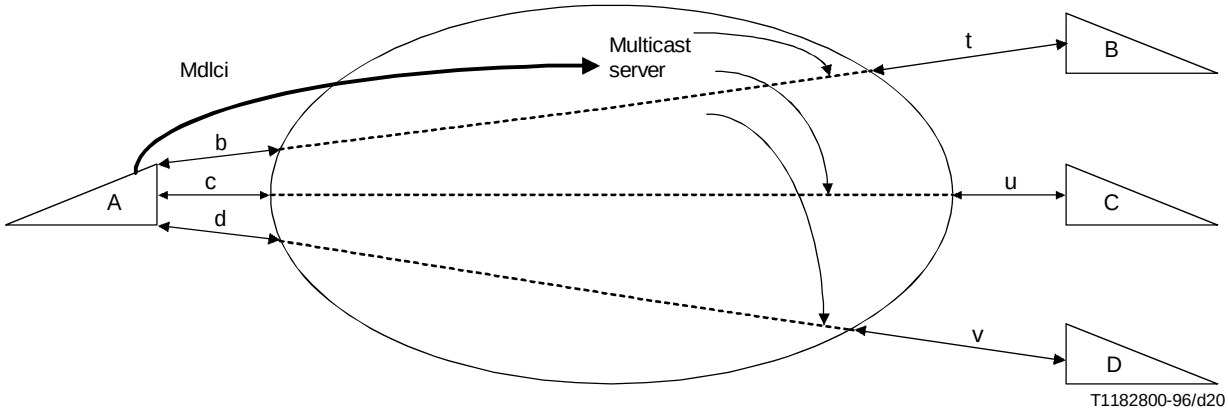


FIGURE II.1/Q.933

One-way Multicast PVC configuration

As defined, the Mdlci is a one-way DLCI. That is, frames are never sent from the network to the root on it. Frames transmitted on the Mdlci which arrive at Station B have no different characteristics from those frames sent from Station A on DLCI "b". Frames from the one-way Multicast Group members to Station A are transmitted on DLCIs "t-v" and arrive on DLCIs "b-d", respectively (see Note). Station A may also exchange frames with a single member of the Multicast Group over one of the DLCIs "b-d".

NOTE – This capability for a leaf to send information back to a root on a different DLCI from the one used by the root to send Multicast information to the leaves is an extension to the one-way Multicast configuration model defined in Recommendation X.6, where the leaves are not permitted to send information back to the root.

II.2.2 Two-way Multicast PVC configuration

The two-way Multicast configuration (see Figure II.2) provides for duplex transmissions. In one direction the data units are Multicast, while in the other, they are concentrated. One participant in a two-way Multicast connection is defined as the root; it functions to send the data units into the Multicast server for Multicasting. The rest of the participants are defined as the leaves. The following rules apply to the two-way Multicast configuration.

- Any data units sent by the root are transmitted to all leaves in the active Multicast Group.
- Any data units sent by a leaf are transmitted to the root of the active Multicast Group, but not to the other leaves.

Station A is the root and stations B, C and D are the leaf members of the Multicast Group. Each participant (both the root and leaves) has two-way connections. The Multicast configuration will accept a frame from Station A on the Mdlci, a, and transmit it to each of the leaf members of the active Multicast Group.

Leaves may return data to the root via the same DLCI. For example, Station C will send frames to Station A on DLCI, c, and they will arrive on station A's Mdlci, a.

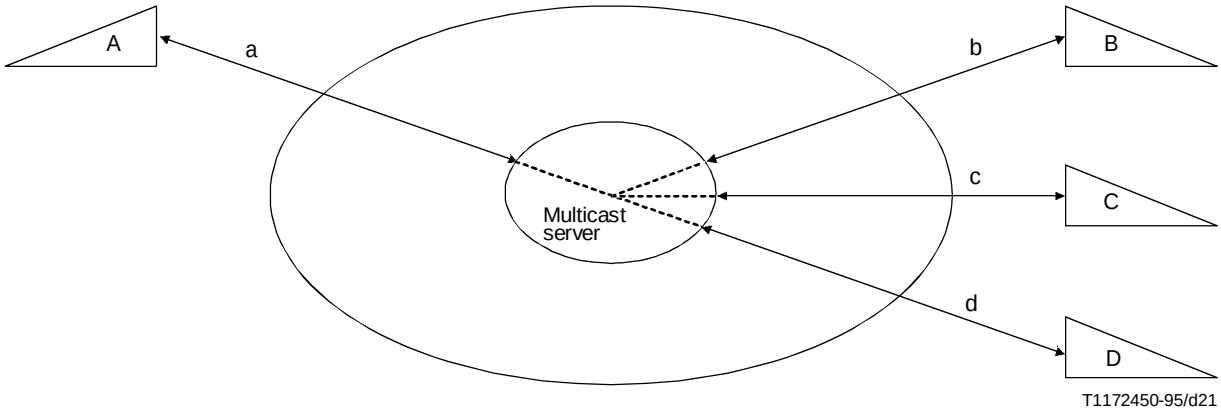


FIGURE II.2/Q.933

Two-way Multicast PVC configuration

II.2.3 N-way Multicast PVC configuration

The third Multicast configuration is n-way Multicasting. All transmissions in this scheme are duplex and all are Multicast. All members of the Multicast Group are transmission peers. Any data sent on a n-way Multicast connection is sent to every other member of the active Multicast Group.

For example, Figure II.3 shows four stations participating in an n-way Multicast exchange. The n-way Multicast configuration will accept a frame on the Mdlci from Station A and transmit it to each of the other members of the active Multicast Group (Stations B, C and D). When the frames reach the destination stations, the DLCI will reflect the Multicast connection which the station may use to address the Multicast Group.

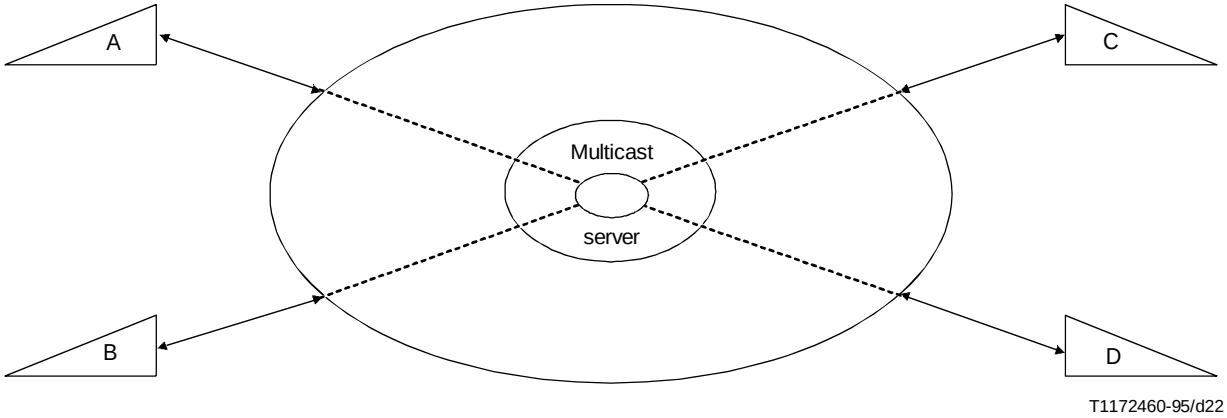


FIGURE II.3/Q.933

N-way Multicast PVC configuration

II.3 Procedures for setting the Active bit of the PVC status information element

When Annex A procedures are used to monitor the status of a Multicast frame relay PVC, the Active bit of the PVC status information element shall have the following interpretations.

II.3.1 One-way Multicast configuration

The Active bit of the PVC status information element for the Mdlci shall be set to one if the Multicast PVC is active to at least one destination. At the leaves of the Multicast configuration, the Active bit shall be set to one when both the point-to-point connection and the Multicast connection are Active.

II.3.2 Two-way Multicast configuration

The Active bit of the PVC status information element, for the root Mdlci, shall be set to one if the Multicast PVC is Active to at least one destination. The Active bit of the PVC status information element, for a leaf Mdlci, shall be set to one if the PVC is Active to the root.

II.3.3 N-Way Multicast configuration

The Active bit of the PVC status information element for the Mdlci of a member of the Multicast Group shall be set to one if the Multicast PVC is Active to at least one other member of the Group.

Acronyms used in this Recommendation

For the purposes of this Recommendation the following abbreviations are used.

ABM	Asynchronous Balanced Mode (of HDLC)
ARM	Asynchronous Response Mode (of HDLC)
BC	Bearer Capability
C_i	Indicated B or H-Channel
C_j	Any B or H-Channel
C_k	Established B or H-Channel
C/R	Command/Response
CONS	Connection-Mode Network Service
D	The D-Channel
DE	Discard Eligible
DLCI	Data Link Connection Identifier
ET	Exchange Termination
FCS	Frame Check Sequence
FH	Frame Handler
FMIF	Frame Mode Information Field
HDLC	High Level Data Link Control (procedures)
IE	Information Element
ISDN	Integrated Services Digital Network
ISO	International Organization for Standardization
LAN	Local Area Network
LAPB	Link Access Protocol Balanced

LLC	Low Layer Compatibility
NRM	Normal Response Mode (of HDLC)
NT2	Network Termination 2
OSI	Open Systems Interconnection
PVC	Permanent Virtual Connection
RFH	Remote Frame Handler
SABME	Set Asynchronous Balanced Mode Extended (frame)
SAPI	Service Access Point Identifier (see Recommendation Q.921)
TA	Terminal Adaptor (see Recommendation I.411)
TE1	Terminal Equipment 1 (see Recommendation I.411)
UA	Unnumbered Aknowledgement (see Recommendation Q.921)
XID	Exchange Identification (see Recommendation Q.921)

References

[1] ITU-T Recommendation Q.931 (1993), *Digital subscriber signalling system No. 1 (DSS 1) – ISDN user-network interface layer 3 specification for basic call control.*

[2] CCITT Recommendation Q.922 (1992), *ISDN data link layer specification for frame mode bearer services.*

[3] CCITT Recommendation I.233.1 (1991), *ISDN frame relaying bearer service.*

[4] ITU-T Recommendation I.320 (1993), *ISDN protocol reference model.*

[5] CCITT Recommendation I.334 (1988), *Principles relating ISDN numbers/subaddress to the OSI reference model network layer addresses.*

[6] CCITT Recommendation I.460 (1988), *Multiplexing rate adaption and support of existing interfaces.*

[7] ITU-T Recommendation X.25 (1993), *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.*

[8] ITU-T Recommendation X.31 (1993), *Support of packet mode terminal equipment by an ISDN.*

[9] ITU-T Recommendation X.75 (1993), *Packet-switched signalling system between public networks providing data transmission services.*

[10] CCITT Recommendation X.200 (1988), *Reference model of Open Systems Interconnection for CCITT applications.*

[11] CCITT Recommendation X.210 (1988), *Open Systems Interconnection layer service definition conventions.*

[12] CCITT Recommendation X.213 (1988), *Network service definition for Open System Interconnection for CCITT applications.*

[13] CCITT Recommendation X.223 (1988), *Use of X.25 to provide the OSI connection-mode network service for CCITT applications.*

[14] CCITT Recommendation X.1 (1988), *International user classes of service in public data networks and Integrated Services Digital Networks (ISDNs).*

[15] CCITT Recommendation V.6 (1988), *Standardization of data signalling rates for synchronous data transmission in the general switched telephone network.*

[16] CCITT Recommendation V.120 (1992), *Support by an ISDN of data terminal equipment with V-Series type interfaces with provision for statistical multiplexing.*

[17] ISO 1745:1975, *Information processing – basic mode control procedures for data communication systems.*

[18] ISO/IEC 4335:1993, *Telecommunications and information exchange between systems – High-level data link control (HDLC) procedures – Elements of procedures.*

[19] ISO 7776:1986, *Information processing systems – Data communications – High-level data link control procedures-Description of the X.25 LAPB-compatible DTE data link procedures.*

[20] ISO/IEC 8208:1990, *Information technology – Data communications – X.25 Packet Layer Protocol for Data Terminal Equipment.*

[21] ISO 8648:1988, *Information processing systems – Open Systems Interconnection – Internal organization of the Network layer.*

[22] ISO/IEC 8802-2:1994, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 2: logical link control.*

[23] ISO/IEC 8473-1:1994, *Information technology – Protocol for providing the connectionless-mode network service: Protocol specification.*

[24] ISO/IEC 8878:1992, *Information technology – Telecommunications and information exchange between systems – Use of X.25 to provide the OSI Connection-mode Network service.*

[25] ISO/IEC TR 9577:1993, *Information technology – Telecommunications and information exchange between systems – Protocol identification in the network layer.*

[26] CCITT Recommendation T.71 (1988), *Link Access Protocol Balanced (LAPB) extended for half-duplex physical level facility.*

[27] ISO/IEC 8802-5:1992, *Information processing systems – Local and metropolitan area networks – Part 5: Token ring access method and physical layer specifications.*